Comprehensive Manuals of Surgical Specialties

Richard H. Egdahl, editor

Abraham T. K. Cockett Ken Koshiba

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Comprehensive Manuals of Surgical Specialties, Volume 5

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We dedicate this manual to our wives, Willia and Kiyo, who assisted materially and editorially in its preparation. They provided encouragement and editorial assistance as we labored diligently for six years, frequently exchanging color photographs, sketches, illustrations, and comments across a distance of 9000 miles.

This manual of operative urology is also dedicated to our colleagues and teachers, especially Elmer Belt and Willard Goodwin.

Editor's Note

Comprehensive Manuals of Surgical Specialties is a series of surgical manuals designed to present current operative techniques and to explore various aspects of diagnosis and treatment. The series features a unique format with emphasis on large, detailed, full-color illustrations, schematic charts and photographs to demonstrate integral steps in surgical procedures.

Each manual focuses on a specific region or topic and describes surgical anatomy, physiology, pathology, diagnosis and operative treatment. Operative techniques and stratagems for dealing with surgically correctable disorders are described in detail. Illustrations are primarily depicted from the surgeon's viewpoint to enhance clarity and comprehension.

Other volumes in preparation:

Manual of Lower Gastrointestinal Surgery
Manual of Vascular Surgery
Manual of Cardiac Surgery
Manual of Liver Surgery
Manual of Soft Tissue Tumor Surgery
Manual of Orthopaedic Surgery
Manual of Upper Gastrointestinal Surgery
Manual of Plastic Surgery
Manual of Ambulatory Surgery

Richard H. Egdahl

Foreword

The color photographs and illustrations appearing in select monographs over the past decade represent a significant advance in surgical communication. Previously, black and white renderings were standard because color printing had not been perfected and its cost was prohibitive. We believe the gradual change from black and white etchings and reproductions to detailed color illustrations represents a tremendous twentieth century achievement.

In our own urologic practices it became evident that the use of black and white sketches for teaching operative urology, while helpful, left too much to the surgeon's imagination. Even the dimension of depth, produced by varying the intensity of shading, often was inadequate in demonstrating subtle surgical details in a fossa or bed.

Since color photography recently has been used to demonstrate operative techniques, we climbed on the bandwagon and photographed in color many of the major operative procedures. However, the reflection of light caused by normal tissue fluid significantly reduces the clarity of photographs. Not infrequently, the crucial operative step is obscured by light reflected on a trickle of blood. Even when meticulous care is taken to irrigate and clean the surgical field, the tissue sheen obscures portions of the field. Color paintings by a gifted artist are not only unique, but can be extraordinary; the vividness with which subtleties can thus be portrayed cannot be matched by photography, black and white or color.

We are confident that these color plates, carefully selected for each operative procedure, will clearly demonstrate the most important steps in the surgical procedure and will materially assist the urology resident in training.

A.T.K. Cockett
K. Koshiba

Preface

The operative procedures illustrated here have been carefully chosen and reflect an obvious bias. We both obtained our formal urologic training at U.C.L.A. and were influenced by our attending and full-time staff, particularly Drs. Elmer Belt and Willard Goodwin. Over the past decade, as we developed our own urologic residency programs, we naturally selected those operative techniques that proved successful in our hands. Some examples include our emphasis on the Belt approach for total perineal prostatectomy, the posterior perineal flap, and the Turner-Warwick staged urethroplasty procedures for difficult deep bulbous urethral strictures. We selected for hypospadias repair the one-stage Devine-Horton modification of the Mustarde operation because of our success with it. The Politano-Leadbetter approach for ureteroneocystostomy is illustrated because we have had excellent clinical results with this intravesical procedure. Our emphasis on transurethral resection of the prostate reflects our years of experience with TURP; we are impressed with this approach, which was developed in the United States and has become a standard routine procedure in most parts of the world.

Both of us are involved in renal transplantation programs that include implantation of the allograft. We have included the vascular techniques that are used routinely today. Renal autotransplantation is a useful alternative in selected instances; our experience with a recent unique case is described. Finally, we include vascular procedures for the surgical treatment of renovascular hypertension. Our broad clinical experience in this area continues to increase.

We believe that the basic techniques and procedures described in this volume will not change significantly over the next several years, although slight modifications probably will occur. Therefore the urologist, from the resident in training through the practicing urologist who may want a manual for review, especially prior to performing a difficult procedure, should find the operative descriptions of great assistance. The illustrations will allow the urologist more rapid recall and comprehension of the relatively unfamiliar urologic procedures. In addition, we believe that the manual will be useful to the general surgeon who, on occasion, will elect to or be required to perform selected urologic procedures via the transabdominal route.

The manual is not all inclusive. A few operative procedures that are performed very infrequently have not been included. Adrenal surgery is not included since Richard Egdahl and colleagues have completed the excellent *Manual of Endocrine Surgery*. We believe that the urologist can obtain appropriate references to those procedures under the anatomic category for that area.

Acknowledgments

We acknowledge the beautiful color renditions of three experts in the field from Kitasato, Sagamihara, Kanagawa, Japan. Isao Takamoto is responsible for most of the color illustrations. Toshio Sekiguchi and Akira Shimazoe, in that order, also contributed significantly to the manual.

A number of my colleagues and associates at the University of Rochester Medical Center also contributed their services: James Hudak photographed many of the surgical scenes, Sue Yells assisted in the typing, and Phyllis Claxton organized and helped with the editing of several drafts. My full-time colleagues in surgery and urology made invaluable suggestions.

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The Kidney

1

Surgical Anatomy

Localization and Fascial Relationships

The kidneys are located in the retroperitoneal space at the level of the upper lumbar region and lie on each side of the spinal column (Fig. 1). The upper half of each kidney lies within the bony thorax. The right kidney is normally at a slightly lower level than the left because of the right hepatic lobe.

The area surrounding the left kidney is quadrilateral in shape, bounded by the 12th rib, iliac crest, vertebral column, and an imaginary vertical line extending upward from the anterior superior iliac spine.

The superficial fascia is arranged between two layers, and the muscles in this region are in three groups:

1. Superficial—the latissimus dorsi and external abdominis oblique
2. Middle—the posterior inferior serratus, sacrospinalis, and internal abdominis oblique
3. Deep—the quadratus lumborum muscle of the loins, the psoas major, and the transverse abdominis muscle

The latissimus dorsi muscle originates from the lower six thoracic vertebrae, all lumbar and upper sacral spinal processes, and also from the supraspinous ligament as it merges with the posterior layer of the lumbodorsal fascia. It derives from fleshy fibers at the outer lip of the iliac crest posteriorly, the last four ribs, and at times, the inferior angle of the scapula. It inserts as a tendon into the floor of the intertubercular sulcus on the humerus.

The anatomic details of the external oblique muscle are discussed in the section on Operative Techniques later in this chapter.

The posterior inferior serratus muscle merges with the lumbar fascia and thus attaches to upper lumbar and lower thoracic spinal processes. It is beneath the latissimus dorsi and passes upward and transversely to ribs 9–12. This muscle depresses these four ribs. Its lowest fibers lie superficial to the posterior lumbocostal ligament, which overlies the lowermost pleural border. Incisions in this area can lead to a pneumothorax as a result of entry into the pleura.

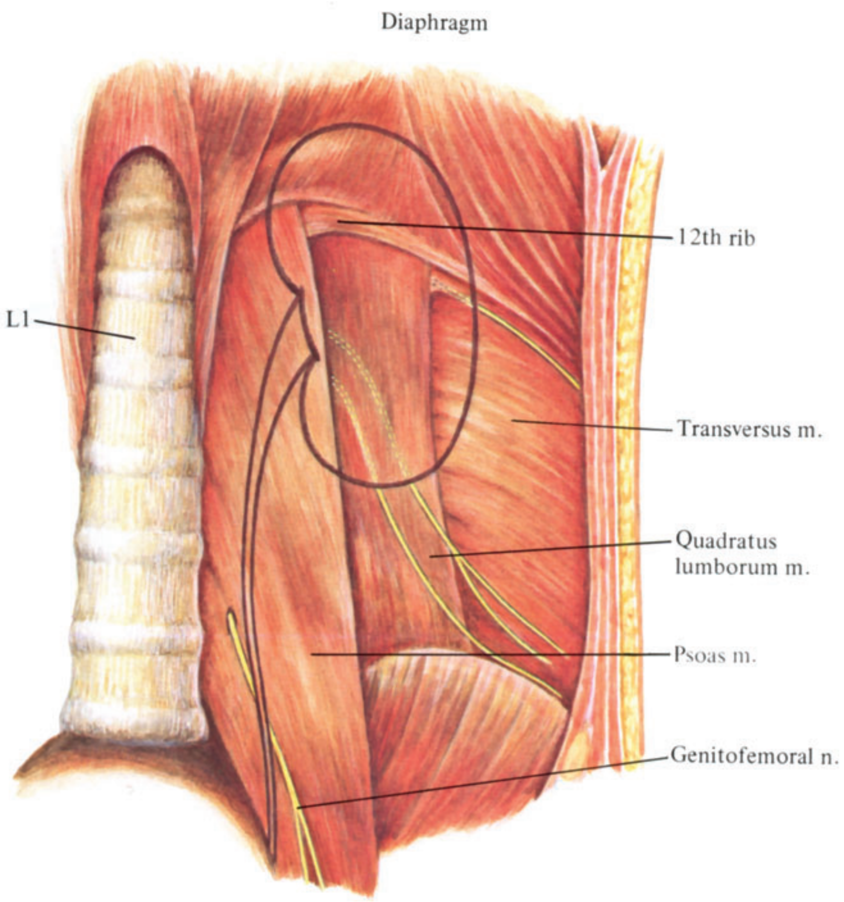


FIG. 1. Normal anatomic relationships of the kidney.

The sacrospinalis muscles are elongated and comprise a group extending from the dorsal sacrum and posterior iliac crest. The group is surrounded by the aponeurotic sheath formed by the posterior and middle layers of lumbodorsal fascia. It has three subdivisions: the iliocostal, the most lateral of the group; the longissimus, widest and bulkiest of the three; and the spinalis muscle, the most medial and shortest of the three.

The internal oblique muscle arises from the iliac crest and inferior part of the lumbodorsal fascia. It forms the floor of Petit's triangle. Its origin and insertion are discussed in the section on Operative Techniques, in relation to exposure of the left kidney.

The quadratus muscle of the loins is a flat muscle lying lateral to the psoas. It arises from the fifth lumbar transverse process, to the posterior part of the iliac crest and the iliolumbar ligament. It inserts into the lower border of rib 12. The anterior and middle layers of the lumbodorsal fascia surround this muscle. The anterior layer of the lumbodorsal fascia separates the muscle from the transversalis fascia.

The psoas major is best considered as an upward migration of the iliac muscle. It occupies the trough between the transverse processes and bodies of the lumbar vertebrae.

The transversus abdominis muscle is described with Fig. 1-5 (p. 10).

The right kidney's anterior surface is related to the liver superiorly, to the descending part of the duodenum near the kidney hilus, and to the hepatic flexure of the colon inferiorly (Fig. 2). The left kidney is adjacent to the stomach superiorly, to the spleen laterally, to the tail of the pancreas

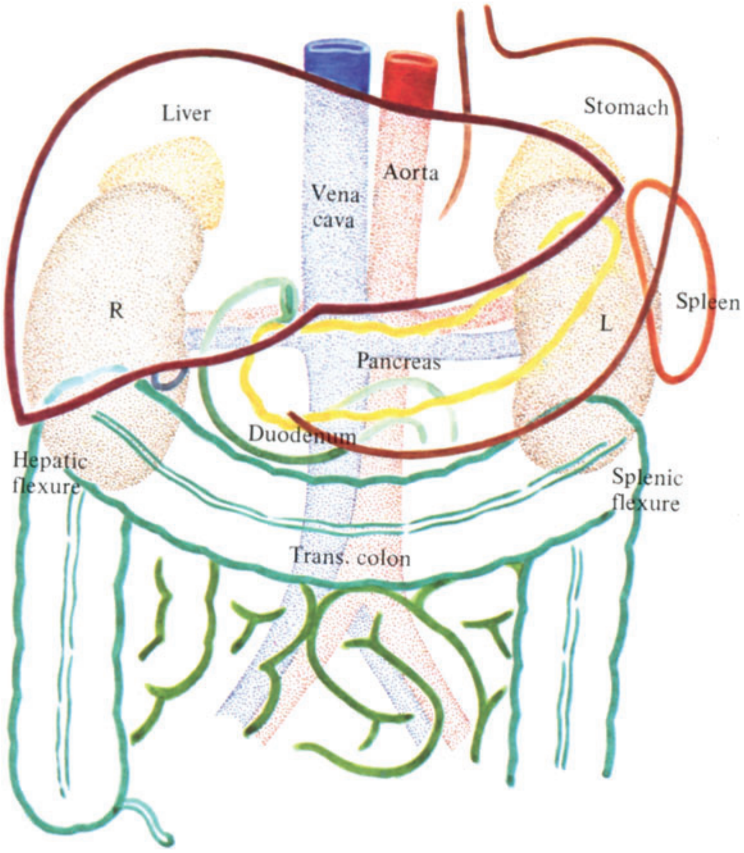


FIG. 2. The right kidney's anterior surface.

near the kidney hilus, and to the splenic flexure of colon inferiorly. Both kidneys are capped by adrenal glands. The gastric and splenic surfaces are covered by peritoneum, as is the hepatic surface, except for a bare fibrotic area attaching to the posterior wall.

The transversalis fascia splits into anterior prerenal and posterior retrorenal fascial layers, forming the capsule of Gerota, which encloses the kidney, adrenal, renal vessels, ureter, and perirenal fat (Fig. 3). These two layers of fascia fuse at the upper pole of the kidney and adrenal gland, but remain open inferiorly and medially. Within this fascial space, the kidney is slightly movable in a thin person.

The lumbodorsal fascia has three layers: anterior, middle, and posterior. The posterior and middle layers are dense and strong. The posterior layer arises from tips of the lumbar, sacral, and thoracic vertebrae. The middle layer arises from the transverse processes of the lumbar vertebrae. The anterior layer arises from the anterior surfaces of the lumbar transverse processes near their roots. The psoas fascia begins from this layer.

As the three layers continue laterally, they fuse near the outer border of the quadratus lumborum. This merger forms a dense tendinous structure—the aponeurosis (origin) of the transversus abdominis muscle. The aponeurosis gives rise, in part, to the internal oblique muscle. Between the posterior and middle layers of lumbodorsal fascia is the sacrospinal muscle group. The quadratus muscle of the loins is between the middle and anterior layer. A cross section of the mid-left kidney (Fig. 4) reveals the full anatomic relationships.

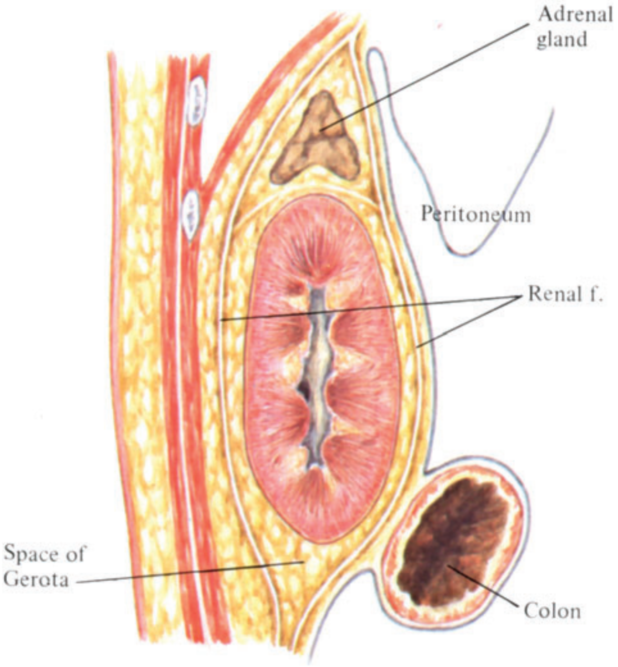


FIG. 3. Capsule of Gerota, enclosing the kidney, adrenal, renal vessels, ureter, and perirenal fat.

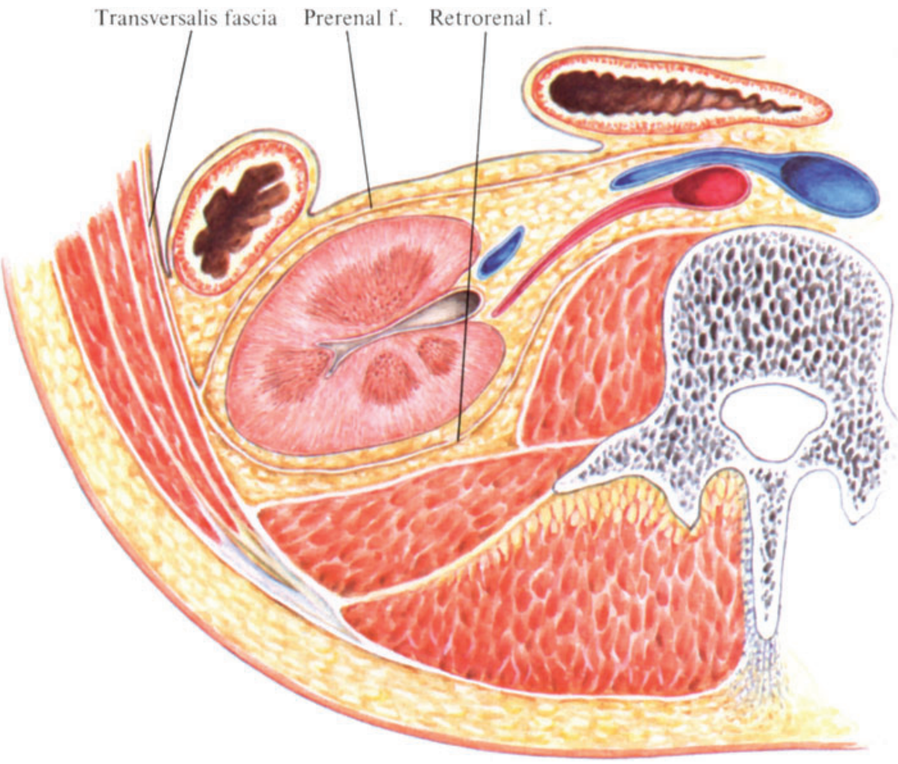


FIG. 4. A cross section of the mid-left kidney, revealing anatomic relationships.

Gross Structure

The kidney is bean-shaped, reddish-brown in color, slightly soft in consistency, and is covered by the capsule, a fibrous membrane which strips easily from the normal kidney (Fig. 5). The adult kidney is 9–12 cm long, 4.5–6.5 cm wide, and 3–4 cm thick. It weighs about 110–140 g.

The kidney parenchyma consists of cortex and medulla. The cortex is thinner than the medulla, about 4–5 mm thick, and contains the glomeruli and convoluted tubules. The medulla is composed of 8–15 striated, conical masses called pyramids. The bases of the pyramids are continuous with the cortex, and their apexes project into the minor calices of the renal pelvis. The tips of the apexes are called the papillae and have openings for the papillary ducts forming the cribriform plate.

Minor calices join to form two or three major calices and open into a single cavity called the intrarenal pelvis. The extrarenal pelvis is funnel-shaped, situated at the hilus of the kidney and joins the ureter at the ureteropelvic junction.

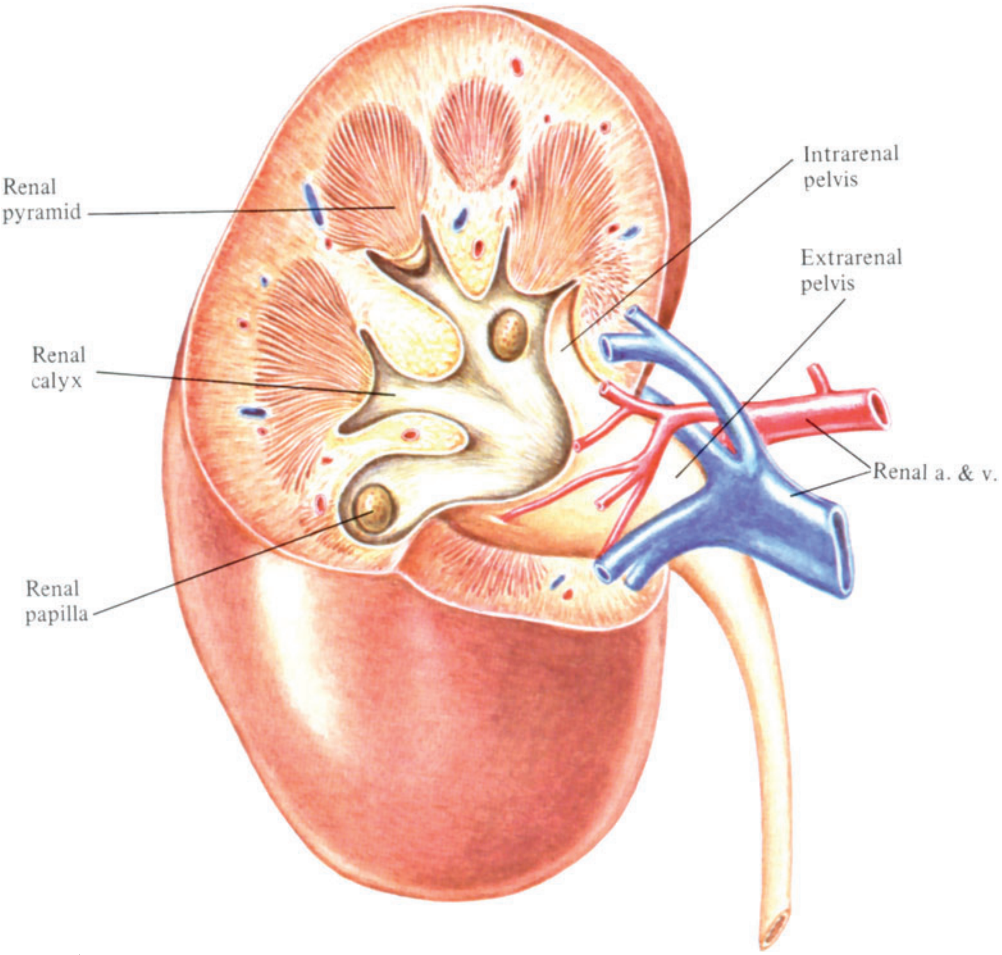


FIG. 5. Gross structure of kidney.

Vascular Supply

The renal arteries arise laterally from the abdominal aorta just below the superior mesenteric artery and pass laterally to each kidney (Fig. 6). The right renal artery courses behind the inferior vena cava and is longer than the left. The renal artery may divide into major branches before entering the kidney hilus. It also sends some branches to the adrenal gland and ureter. Accessory renal arteries may branch from the aorta and enter the kidney near the upper or lower pole. Occasionally the inferior accessory artery passes behind the ureter and interferes with urinary drainage from the kidney. These accessory branches may cause troublesome bleeding if unrecognized during surgery.

The renal veins lie anterior to the accompanying arteries and anastomose freely. The left renal vein courses anterior to the aorta, and is longer than the right vein. The left ovarian or spermatic vein joins the left renal vein, whereas the right empties directly into inferior vena cava. Duplication of the left renal vein is rare; however, the right renal vein may be single, double, or triple, and is shorter than the left. The vena cava lies in close proximity to the right kidney and can be injured if it is unrecognized and traumatized when the kidney is mobilized during surgery. Accessory renal veins are infrequent. Accessory renal arteries are not usually accompanied by veins.

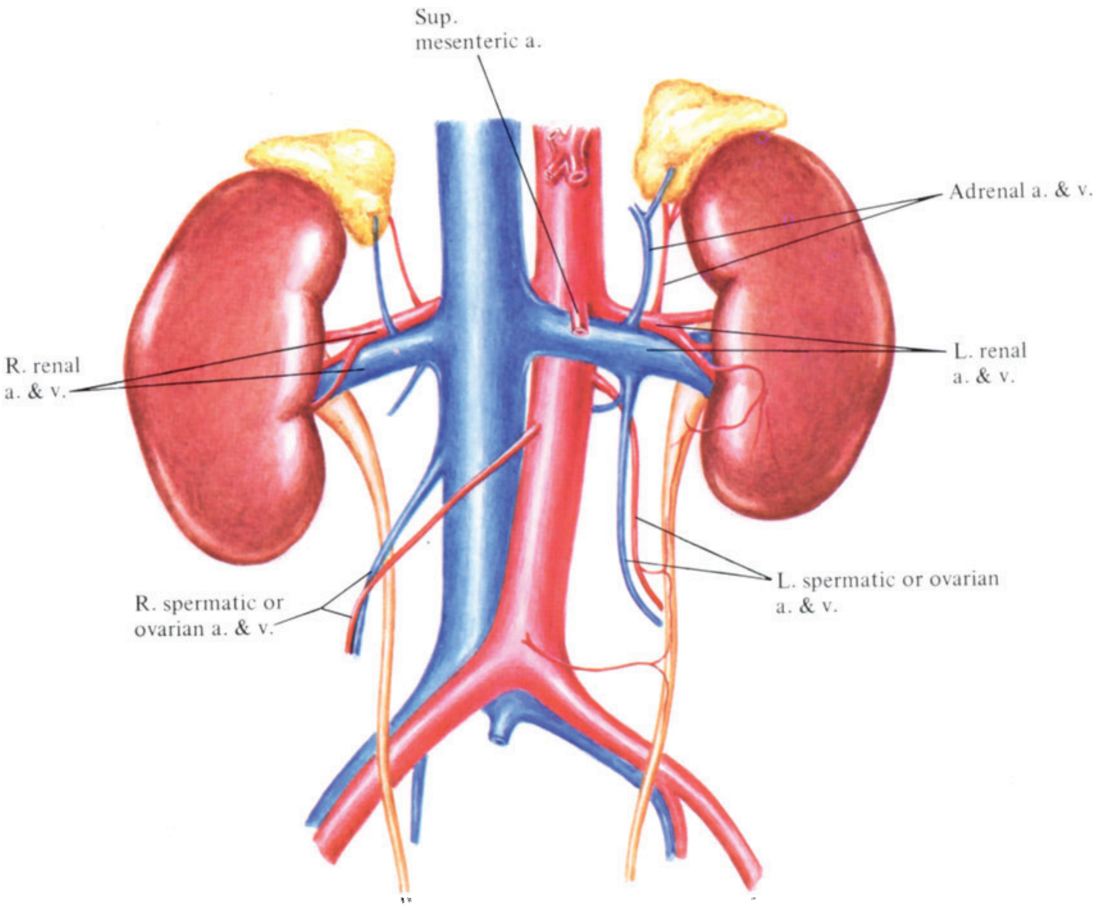


FIG. 6. Vascular supply to the kidney.

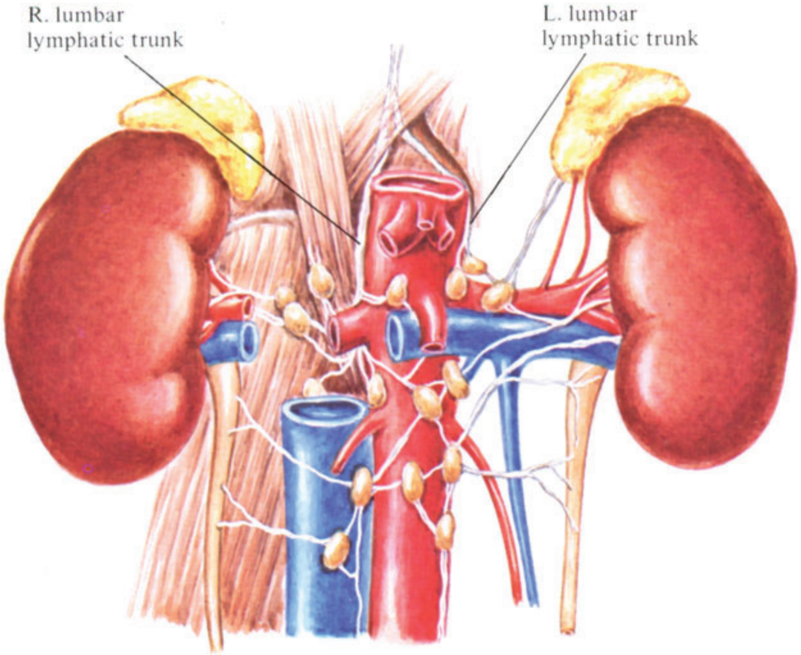


FIG. 7. Lymphatic network of the kidney.

Lymphatic Network

The intrarenal lymphatics within the renal parenchyma consist of a cortical and a medullary network and drain into lymph nodes surrounding the renal pedicle (Fig. 7). The lymphatics emerge from the hilus via larger trunks. From there they drain into retrocaval trunks in the region of the inferior vena cava and aorta. The extrarenal lymphatic network of the kidney communicates freely with the adrenal gland lymphatics and periureteral sheath.

Cortical lymphatics at the outer renal cortex communicate with the lymphatics of the renal capsule. The lymphatics at the inner cortex and corticomedullary junction course through the medulla to the hilar network.

Nerve Supply

The kidneys are supplied with sympathetic and parasympathetic nerves. Sympathetic fibers are derived from the greater and lesser splanchnic nerves and pass to the renal plexus via the celiac and superior mesenteric ganglia. Parasympathetic fibers also course to the kidney. The majority of nerve fibers run along the renal artery to the kidney, along the upper, lower, and posterior aspects of the artery. They are adherent to the distal portion of the renal artery. A few nerve fibers are received directly from the solar plexus and course as splanchnic nerves to the kidney and its capsule.

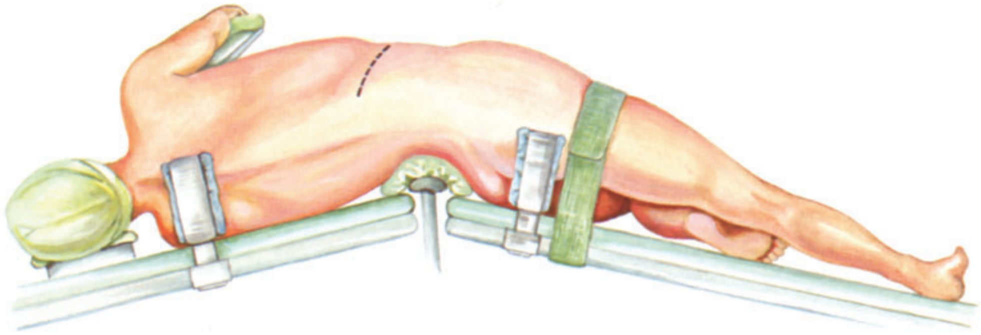
Operative Techniques

1. Lumbar–Flank Approach

1-1. After the induction of anesthesia and insertion of an endotracheal tube, *the patient is positioned on his or her side* with the appropriate kidney exposed (a). The surgical table is flexed to place tension at the incision site. Adhesive tape (3-inch) can be used to secure the position at the hip and shoulder. The arm is elevated on a horizontal plane. The knees should be protected.

The *line of incision (b) can be made below the 12th rib* or over the distal half of the 12th rib. It is carried through the skin and subcutaneous fat, exposing the external oblique muscle. If rib resection is required, the incision is extended over the body of the 12th rib.

1-2. *A lumbar incision, left anterior oblique approach, can be used* as an alternative to the approach seen in 1-1. Ribs 10, 11, and 12 are depicted for orientation.



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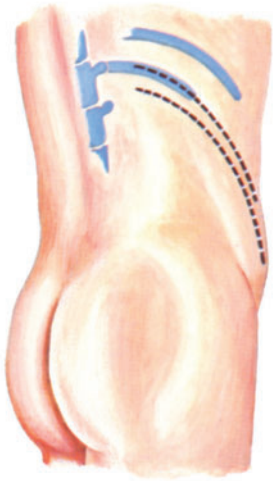

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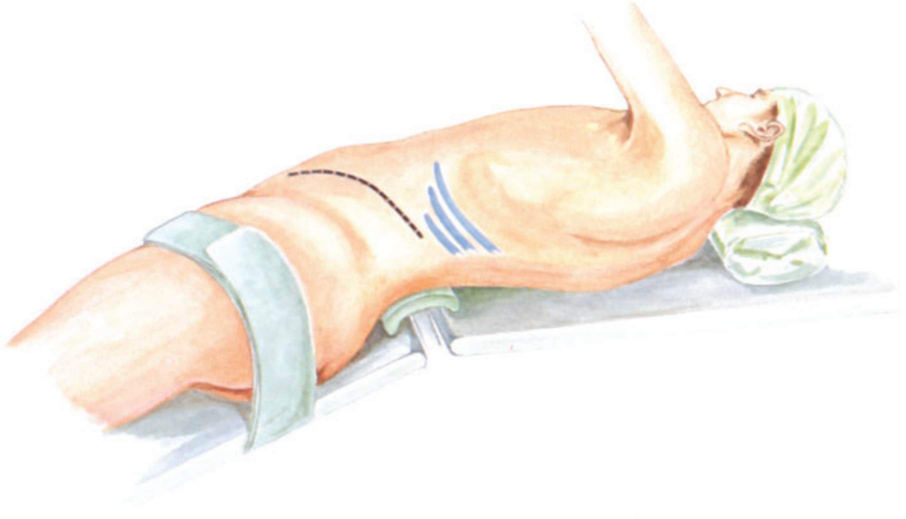
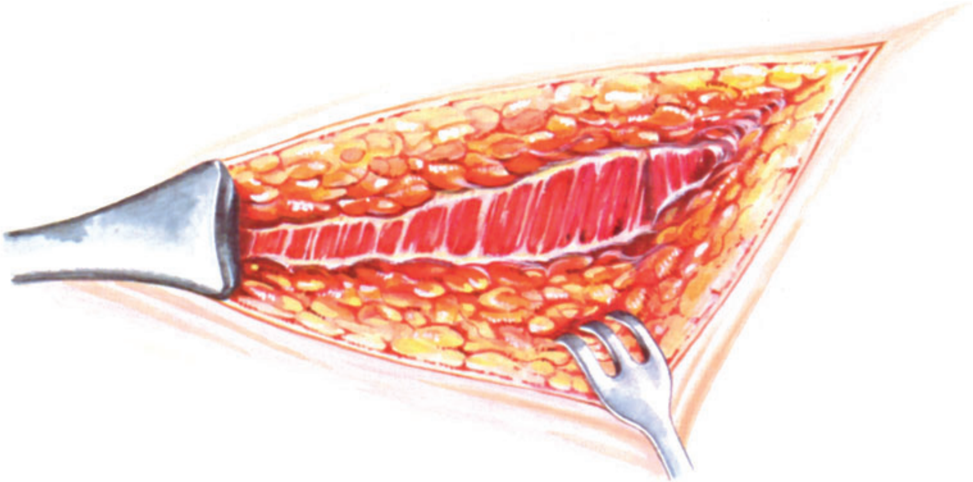


1-2

Exposure of Left Kidney

1-3. Skin and subcutaneous bleeders are secured. *The incision is carried* in depth *to obtain exposure of the external oblique muscle.* The external abdominal oblique muscle arises from the lower eight ribs (5–12). It inserts on the anterior half of the iliac crest. *Fascia covering this muscle extends* from the anterior border of Petit's triangle *between the 12th rib and the iliac crest.* The external oblique aponeurosis forms the inguinal and Cooper's ligaments. The free posterior border is located at the midpoint of the iliac crest.

1-4. *The internal oblique muscle is a fan-shaped muscle* with a narrow origin and a broad insertion. It lies between the external oblique and transversus abdominis muscle and originates from the outer half of the inguinal ligament, the intermediate line on the iliac crest and the posterior lamella of the lumbodorsal fascia.



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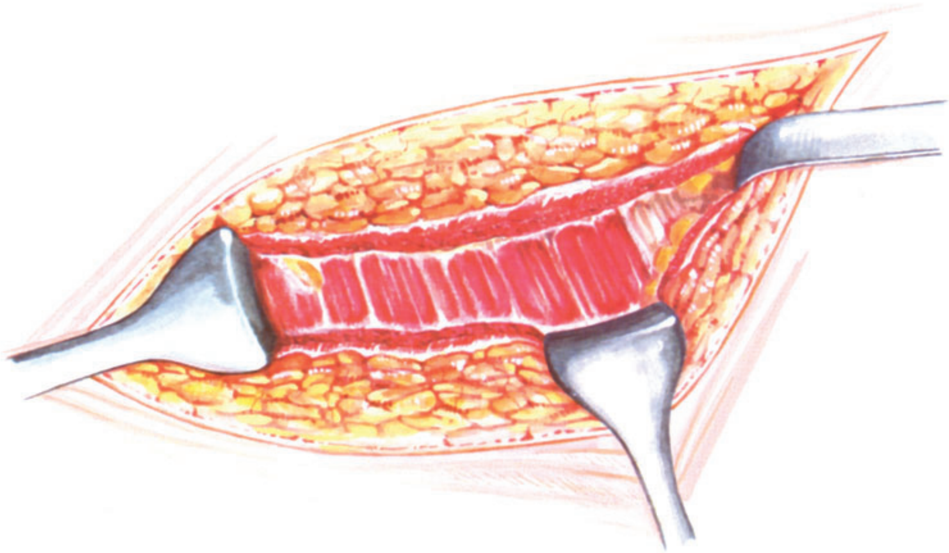


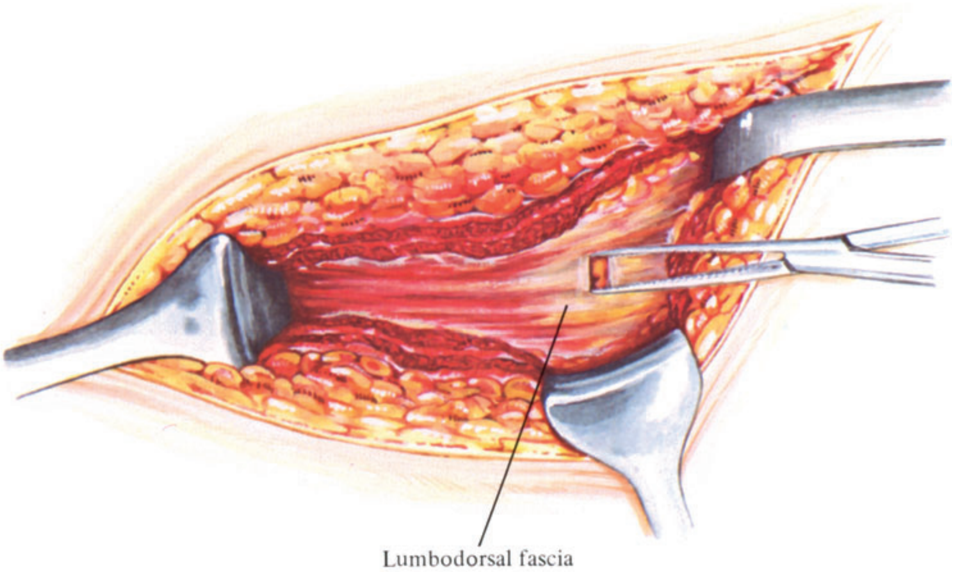
1-4

This muscle has no free posterior border. The uppermost fibers run vertically upward into the lower four ribs and their cartilages. The intermediate fibers form an aponeurosis at the line of Douglas. Above the semicircular line it divides into two lamellae at the lateral wall of the rectus muscles. The anterior wall of the rectus sheath consists of the aponeurosis of the external oblique and the anterior layer of the internal oblique aponeurosis. The posterior rectus sheath or wall is made up of the posterior layer of the internal oblique aponeurosis, the aponeurosis of the transversus abdominis muscle and transversalis fascia. Below the line of Douglas, the combined aponeuroses of all three lateral abdominal muscles fuse and pass in front of the rectus sheath as the anterior rectus sheath. Its fibers in the flank region run at right angles to the more superficial external oblique muscle.

1-5. The internal oblique muscle is now incised, exposing the transversus abdominis muscle and lumbodorsal fascia.

The transversus abdominis muscle is the deepest of the three lateral abdominal muscles. It originates from the outer third of the inguinal ligament, the inner lip of the iliac crest, from the middle layer of the lumbodorsal fascia, and from the inner surface of the lower six costal cartilages. Insertion is into the linea alba and through the conjoined tendon into the pubic crest. Its fibers, in the main, are directed horizontally. The aponeurosis passes behind the rectus muscle to the level of the line of Douglas. Below this level it passes in front of the rectus.

Transversalis fascia (endoabdominal fascia) covers the entire internal surface of abdomen. The fascia covers certain muscles and assumes its name from that muscle. Below the inferior margins of the internal oblique and transversus abdominis muscles the fascia is well developed. It forms the floor of Hesselbach's triangle; weakness leads to a direct inguinal hernia. It lies between transversus abdominis muscle and the properitoneal fat layer. In lean patients it adheres to parietal peritoneum as one layer.



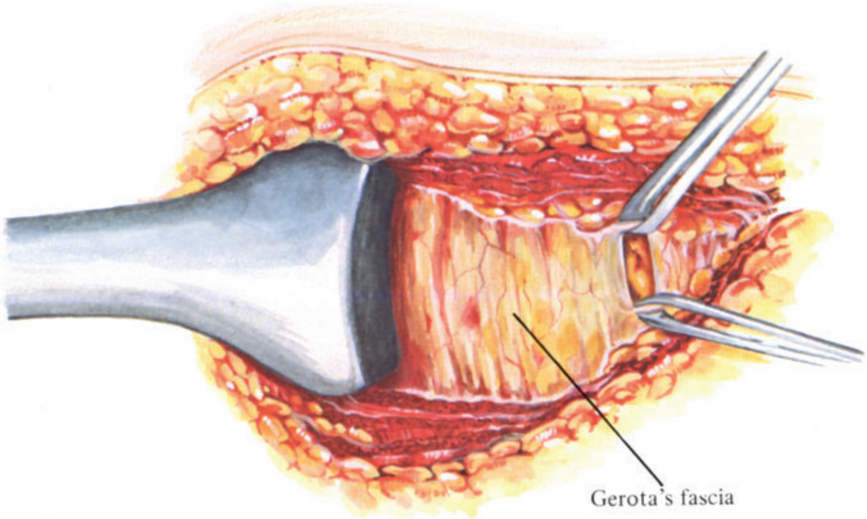
1-5

Care should be taken to preserve the 12th thoracic and first lumbar nerves coursing between the internal oblique and the transversus abdominis muscles. A window is made in the lumbodorsal fascia to facilitate blunt separation of the transversus abdominis.

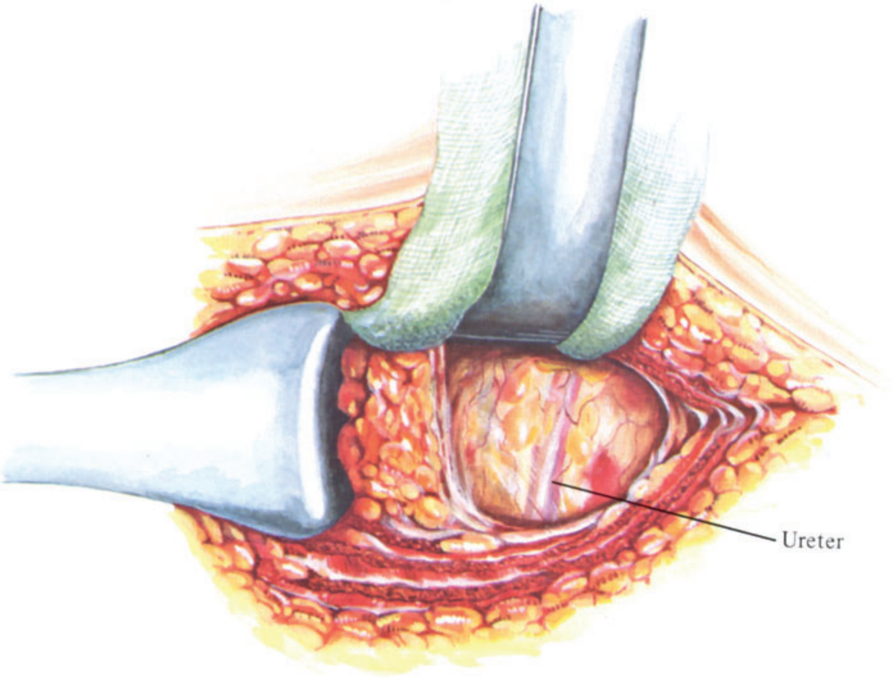
1-6. *Gerota's fascia, which invests the kidney, has been opened,* allowing exposure of the perirenal fat.

1-7. *The ureter is identified and carefully exposed* by lifting the lower pole of the kidney and moving it medially. This maneuver is done to avoid possible damage to the ureter.

Once the kidney has been exposed in this fashion, a number of operative procedures can be undertaken. See the sequence of illustrations for



1-6

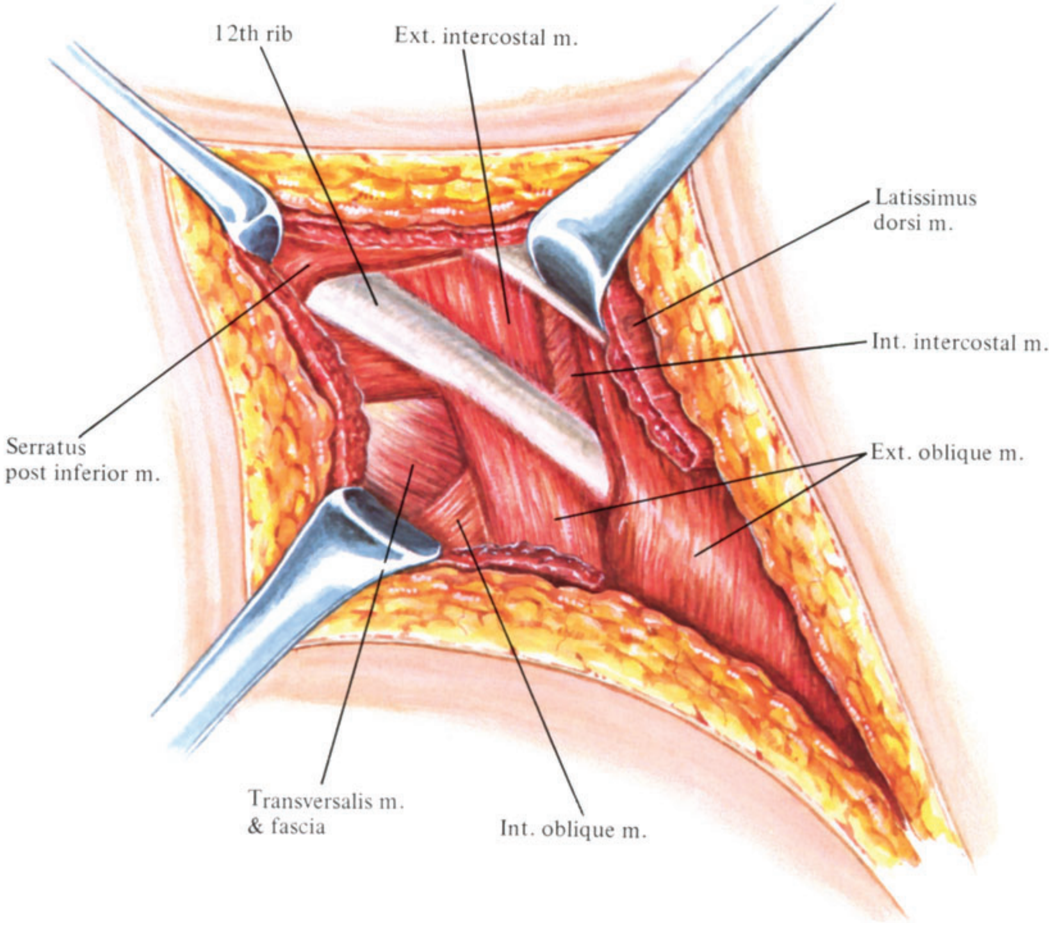


1-7

pyelolithotomy. On occasion, when the lumbar flank approach is being used and greater exposure is needed, the technique of rib resection can facilitate the operative procedure. (Technique of 12th rib resection, right side.)

1-8. After the incision is made, exposing the external oblique muscle (see Figs. 1-1 and 1-3), *the incision is extended over the body of the 12th rib.* In sequence, the appropriate slips of the external oblique, internal oblique, and latissimus dorsi muscles are transected to expose the body of the rib. Care is taken to avoid exposing the inferior concave end of the rib because of the intercostal blood vessels and nerve.

1-9. The *periosteum is incised along the body of the rib,* and a periosteal elevator is used to develop the subperiosteal plane. Dissection of periosteum at the lateral rib borders is facilitated by use of the Alexander periosteotome. If the surgeon wishes to expose the 11th rib, care is necessary to avoid tearing the underlying pleura. If the pleural space is opened inadvertently, a catheter (16–17 French) is left in place during closure and removed after residual air is expressed by hyperinflation of the lungs before the skin closure is completed.



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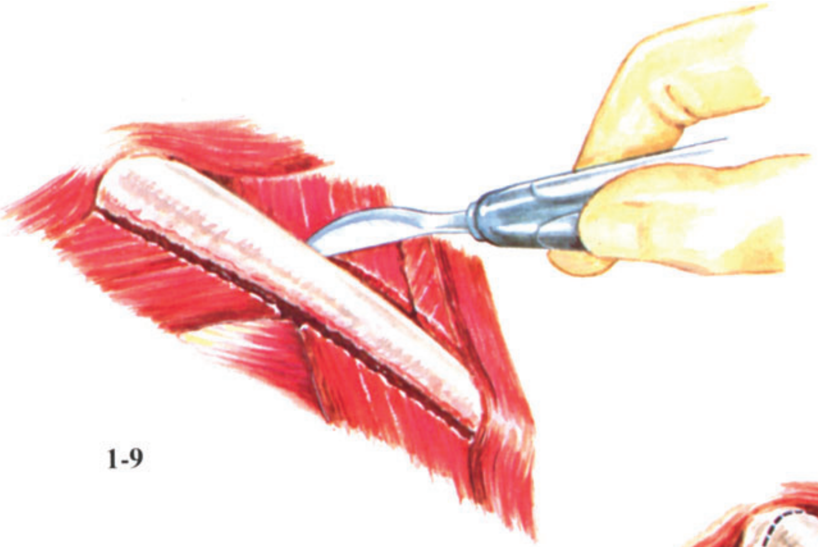
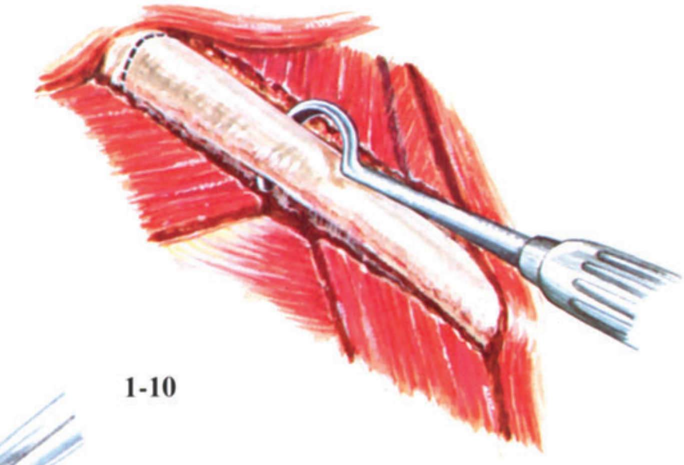


1-9



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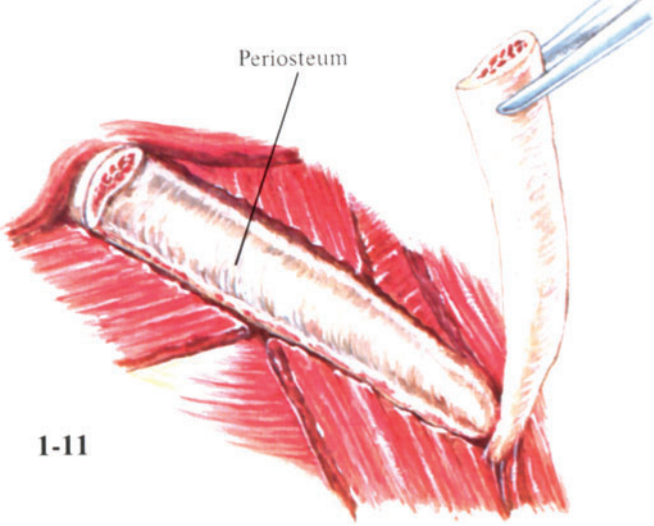


1-11

1-10. *The Doyen instrument (left or right) is used to develop the subperiosteal space* behind the rib and free it for the next surgical maneuver. If bleeding is encountered from the intercostal vessels, hemostasis is established. If the procedure for exposing the external oblique muscle has been followed, clamping and dividing the intercostal vessels are obviated, thus preserving the subcostal nerve which parallels the vessels.

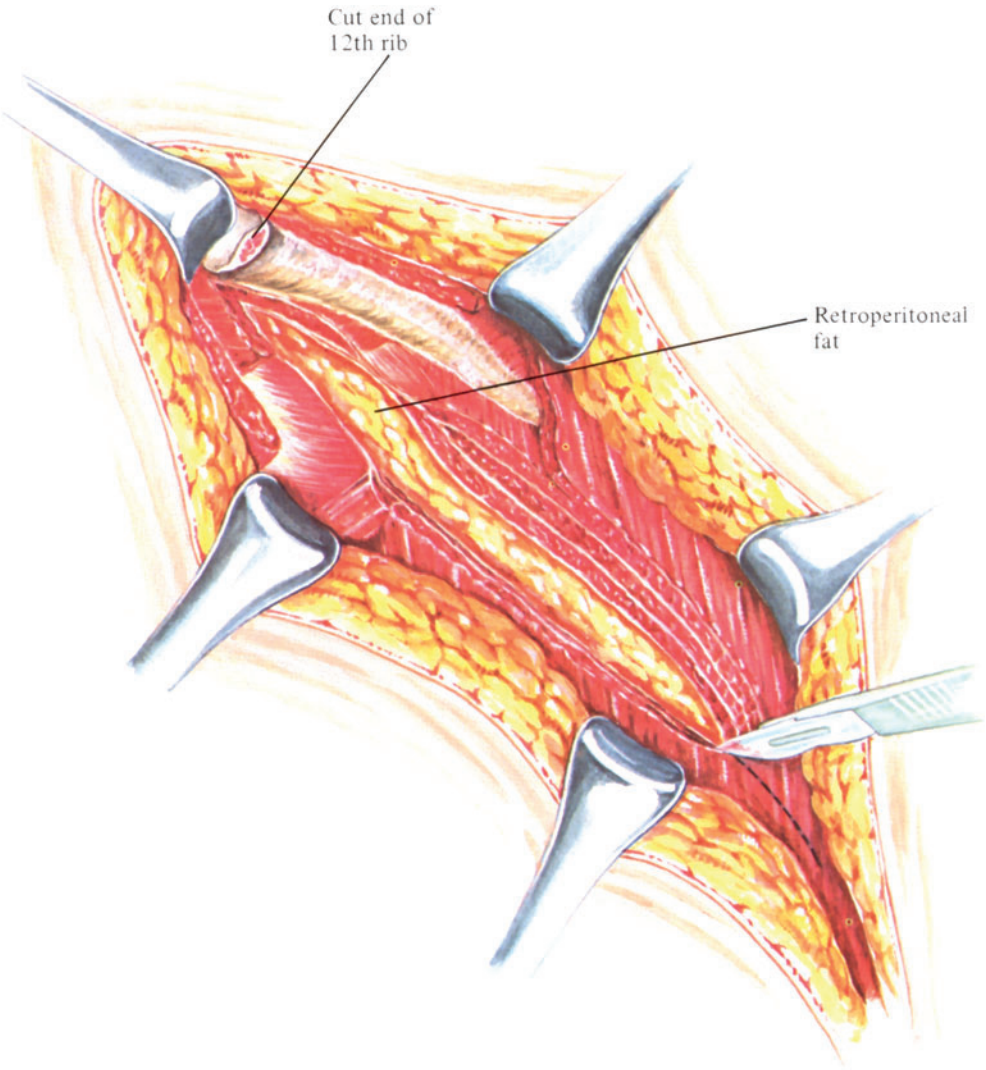
1-11. The proximal end of *the rib is transected* and *lifted from the underlying subperiosteal bed.* The distal portion of the rib is similarly transected.

1-12. The rib is moved and *the flank muscles are incised,* exposing the retroperitoneal fat.

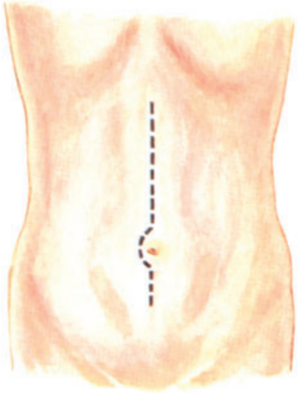
An alternative may be useful to the surgeon: After the rib has been removed, the distal periosteal bed can be used to develop an avascular blunt plane of dissection beneath the medial abdominal muscles. This maneuver also allows the peritoneal wall located near the rib to be pushed medially by several fingers and allows the index and middle fingers to increase tension anteriorly on the muscles for further dissection and hemostatic control. The kidney can now be visualized, invested by Gerota's fascia and surrounded by pararenal fat.

2. Anterior Abdominal-Transperitoneal (Transabdominal) Approach

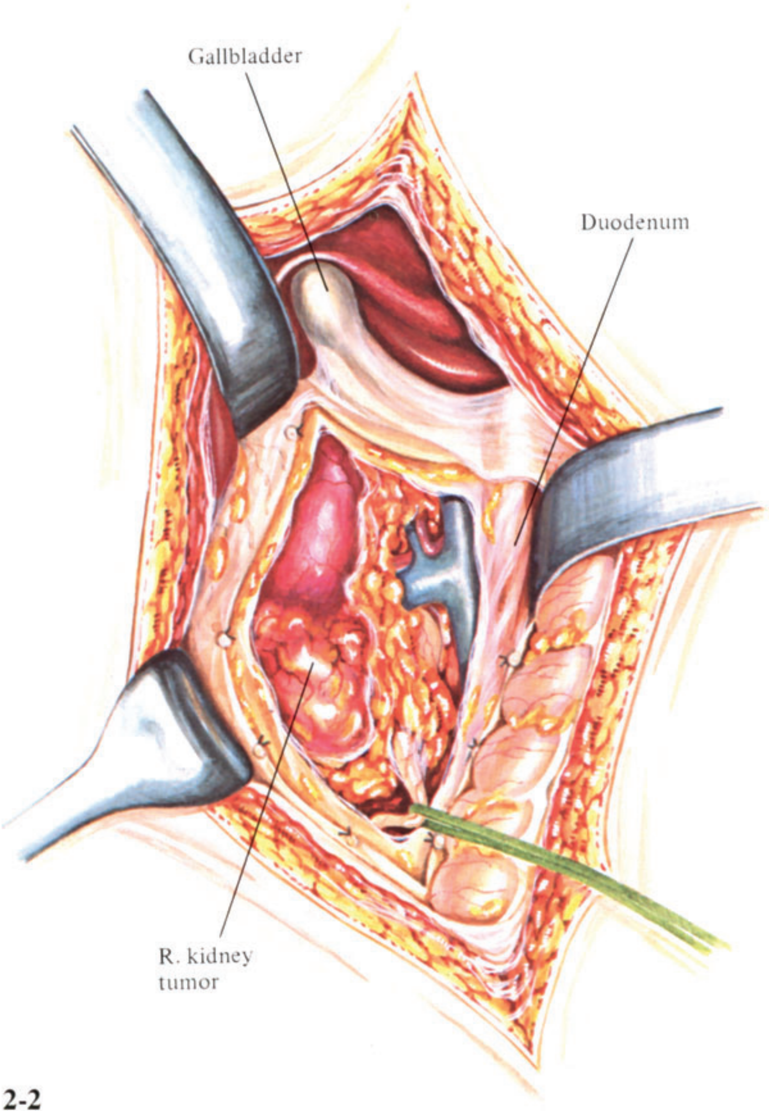
On occasion a much wider exposure and field may be required than is permissible by the approaches that have been described. When a patient has significant pulmonary insufficiency, the supine position allows for more efficient respiratory exchange and more effective monitoring by the anesthesiologist. This approach is also useful when a large kidney mass is present.



1-12



2-1



2-2

Renal vessels can be more readily exposed and controlled near their site or origin. The anterior route, for example, is favored by general surgeons who are operating on patients with intraabdominal pathology because it permits excellent exposure and easy access to the appropriate organ.

2-1. *A vertical midline incision of the skin is made.* A subcostal oblique line of incision similar to that used in approaches to the gallbladder can be employed, and is one that we favor.

2-2. The peritoneal cavity is entered. Routine inspection and palpation of the abdominal contents is carried out. *The right kidney and fascial attachments are exposed* by incising the lateral attachments of the ascending colon and reflecting the colon medially. A neoplasm is identifiable through Gerota's fascia in the lower pole of the right kidney. The duodenum has been retracted medially after kocherizing its lateral border, exposing the inferior vena cava and right renal vein. The renal artery is barely visible in the illustration because it lies posteriorly to the right renal vein and inferior vena cava. The renal artery must be controlled at the outset. This can be accomplished in several ways: 1) Identify the medial border of both the inferior vena cava and abdominal aorta. 2) Pass an umbilical tape under the vena cava superior to the renal vein; blunt dissection will usually circumvent a posterior lumbar vein. 3) Gently lift the vena cava to allow dissection of the right renal artery distal to its origin but between the great vessels. 4) Several ligatures are passed (1-0 silk) around the renal artery. Prior to excision the ureter has been identified and retracted medially.

Another approach to the right renal artery may be advantageous if the kidney mass is of moderate size. The renal vein is freed and an umbilical tape is passed. Inferior traction of the vein will expose a portion of the renal artery. Careful dissection will allow the placement of ligatures around the artery. Early branching of the renal artery is fairly common at this site. Therefore, this maneuver may not permit the surgeon to have a full visual field, and only partial arterial hemostasis may be achieved.

A third approach to the renal artery can be considered. The kidney and its investments can be dissected posteriorly, starting at the periphery and extending to the hilus. The renal artery can now be palpated, and carefully dissected. Gently lifting the kidney can place the renal artery on slight tension, and its course can be traced to the appropriate point of ligature.

We strongly suggest individual ligation of the artery and vein, respectively, rather than mass pedicle ligation, which is often performed blindly. The renal artery and vein are individually ligated and divided between ties. The ureter is similarly ligated and cut. The kidney and tumor mass can be further dissected and removed.

2-3. *In the anterior transabdominal approach to the left kidney, the descending colon is retracted medially.* The procedures described for the approach to the right kidney are surgically performed. The renal vessels are individually ligated on the proximal half. The distal vessels are secured with a clamp. The ureter is ligated inferiorly, and the superior portion is secured with a clamp. The illustration depicts total nephrectomy with en-bloc removal of Gerota's fascia, except for the upper pole of the left kidney.

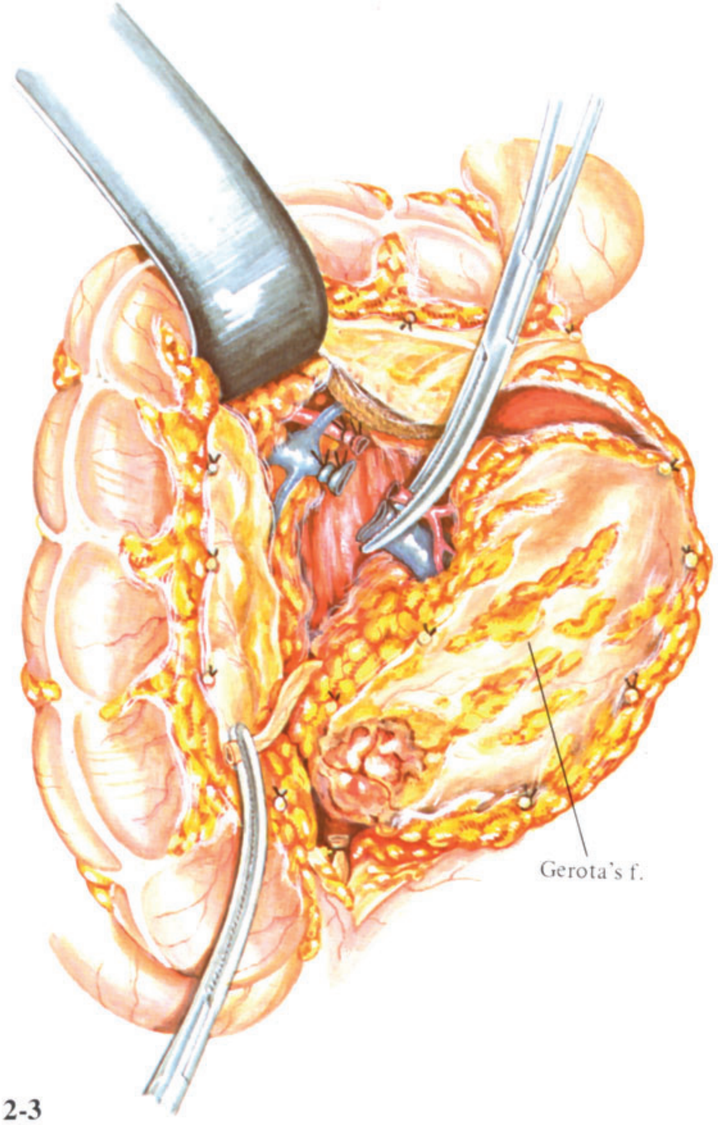
3. Thoracoabdominal Approach

When the kidney tumor engulfing the upper pole is large (greater than 10–15 cm), and malignancy is suspected, a planned thoracoabdominal approach is best considered. This provides the wide exposure necessary for radical en bloc resection of the tumor, which may involve removal of the ipsilateral adrenal gland.

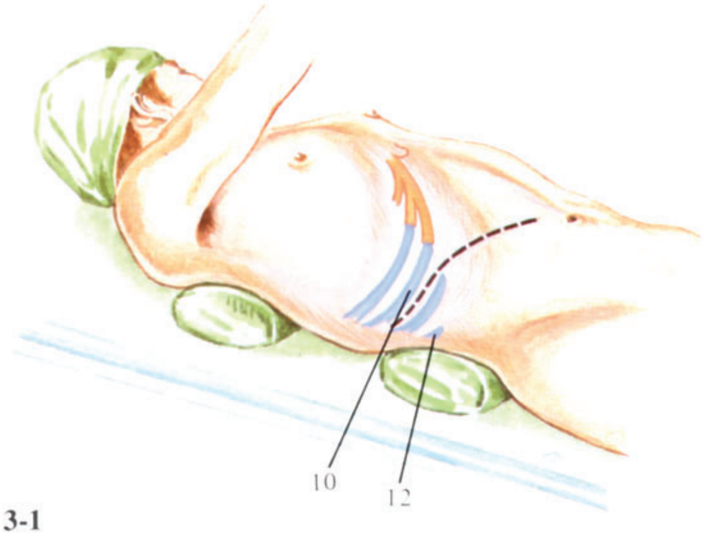
A preoperative work-up is mandatory. An intravenous urogram is essential for diagnosis and to verify the presence of a contralateral functioning kidney. Selective renal arteriography is helpful in planning operative strategy. Computerized axial tomographic (CAT) scanning is also helpful diagnostically. An inferior venacavogram may provide information relevant to local resectability of the tumor. High vena caval invasion may dictate unresectability or use of cardiopulmonary bypass.

The following sequence of illustrations demonstrates the operative approach after a diagnosis of right renal neoplasm.

3-1. The patient is positioned on the table in a recumbent position with the right side elevated 40° by sandbags or pillows. *The planned incision* is



2-3



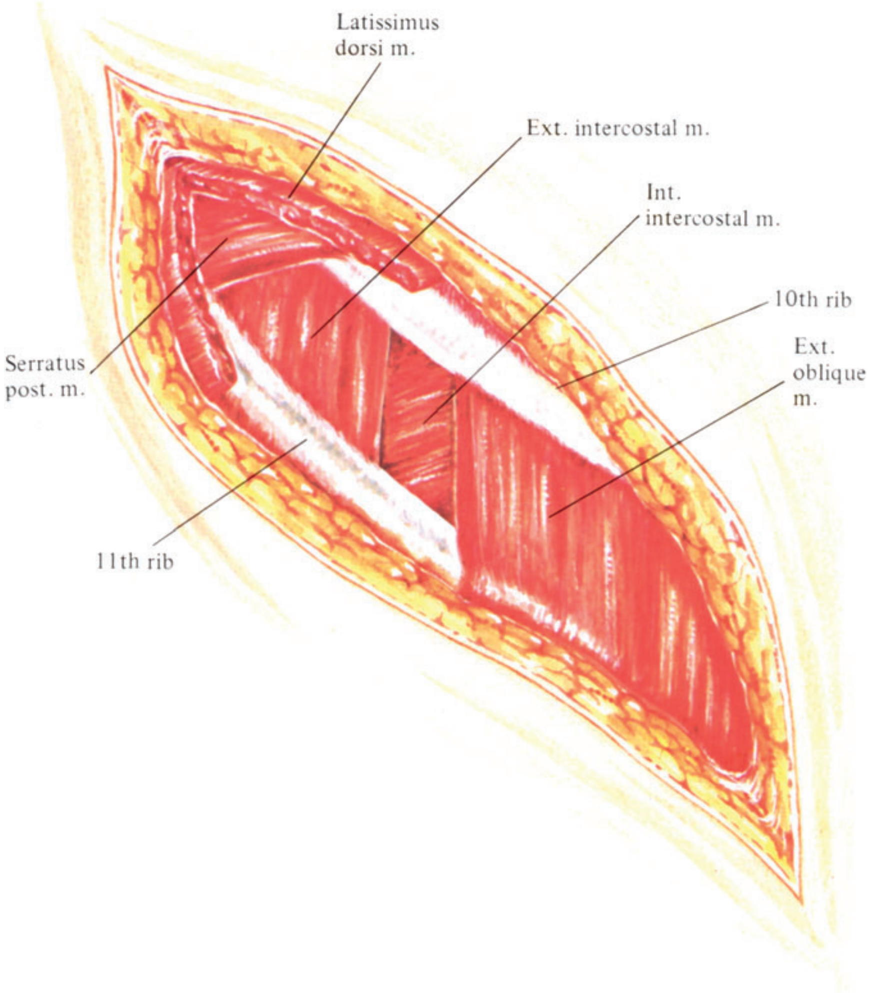
3-1

indicated by the broken line. The abdominal component of the incision extends transversely and slightly inferiorly across the midline from the lateral edge of the left rectus muscle to the right costal margin opposite the tenth interspace. The rectus muscle on the right side is divided, and the incision is carried down through the peritoneum to enter the abdomen.

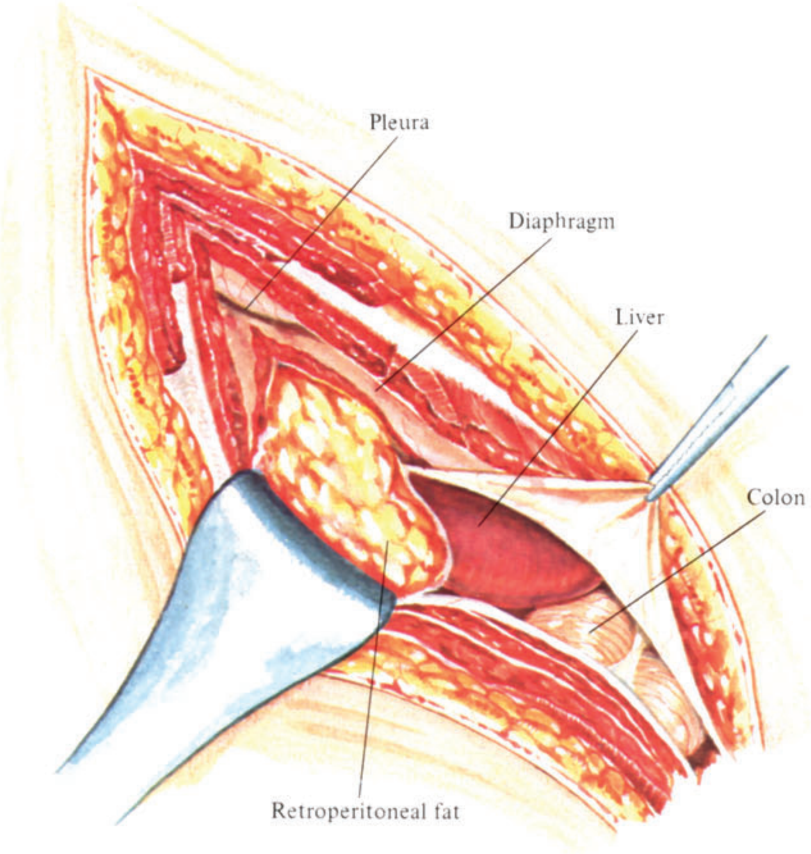
3-2. Through a thoracic incision exposing the tenth interspace, *the latissimus dorsi muscle is incised,* exposing the external and internal intercostal muscles.

3-3. *The thoracic component of the incision is extended across the costal margin* and through the tenth intercostal space *into the right pleural cavity.* The diaphragm is divided in the direction of the chest incision. The liver edge and retroperitoneal fat are seen, along with the hepatic flexure of the colon.

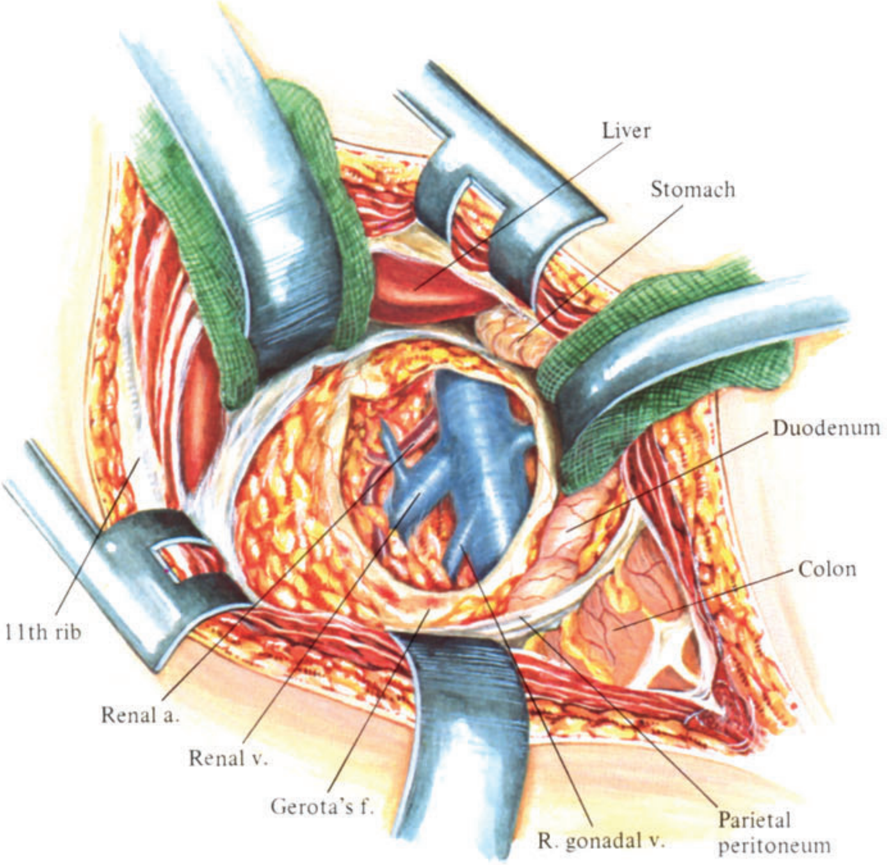
3-4. In this portion of the incision (abdominal) are the *inferior vena cava, renal artery and vein, and Gerota's fascia* surrounding the kidney, as well as portions of liver, stomach, duodenum and colon. The duodenum has been mobilized and retracted medially exposing the vena cava and right renal vein. The renal artery is exposed, dissected, and doubly ligated behind the vena cava. The renal vein is also doubly ligated and transected in between. The ureter is exposed, doubly ligated, and divided. Fascial attachments of the kidney to the undersurface of the liver are removed by incising the peritoneum superiorly. The tumor mass and kidney are then removed. The adrenal gland (at right) is removed with the mass if tumor extension is noted.



3-2


Pleura
Diaphragm
Liver
Colon
Retroperitoneal fat

3-3


Liver
Stomach
Duodenum
Colon
11th rib
Renal a.
Renal v.
Gerota's f.
R. gonadal v.
Parietal
peritoneum

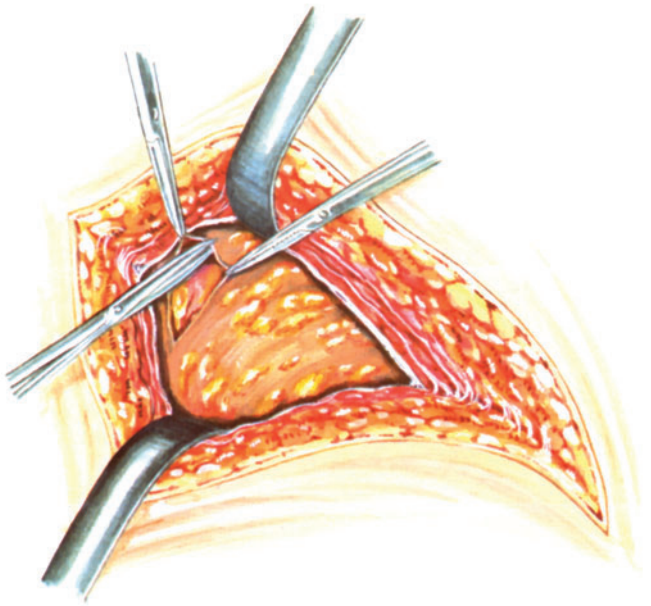
3-4

Nephrectomy

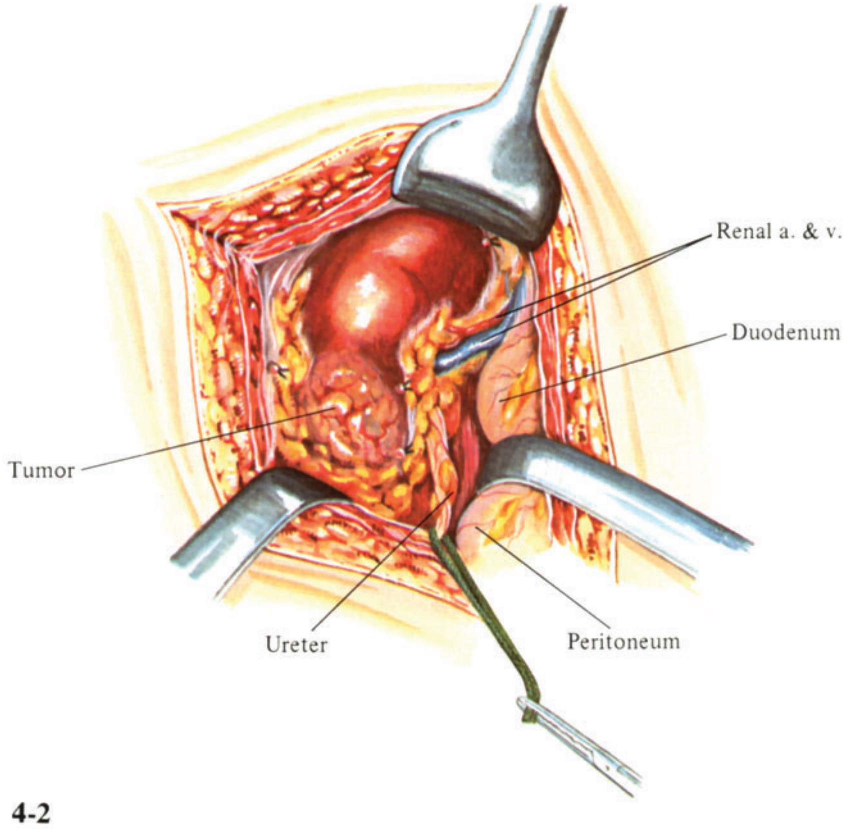
4. Standard Nephrectomy

For a routine nephrectomy procedure, any of the previously described surgical approaches can be used. In the following sequence, the right anterior transabdominal approach is employed.

4-1. *The ascending colon is retracted medially;* the duodenum is then freed and similarly retracted. Gerota's fascia is opened, exposing the right kidney. If a renal adenocarcinoma is suspected, the fascia is left intact.



4-1



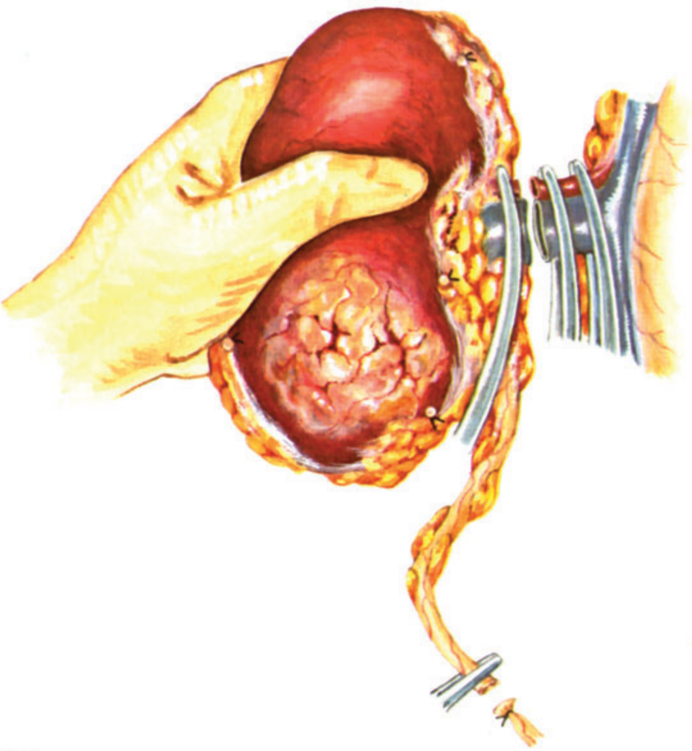
4-2

4-2. *The lesion at the lower right pole of the kidney is exposed* along with its vascular supply. The ureter has been isolated and retracted inferiorly by a tape.

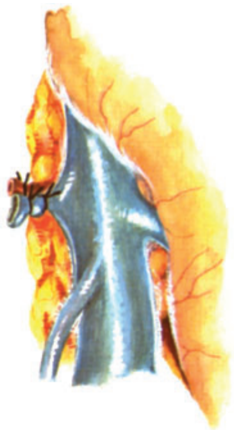
4-3. *The double-clamp technique is used on the proximal end of the renal vasculature.* (Usually we elect to isolate and clamp each vessel individually.) The renal artery is isolated and ligated first (see Fig. 2-2); this is followed by ligation of the right renal vein.

4-4. *The right renal vessels are doubly ligated.*

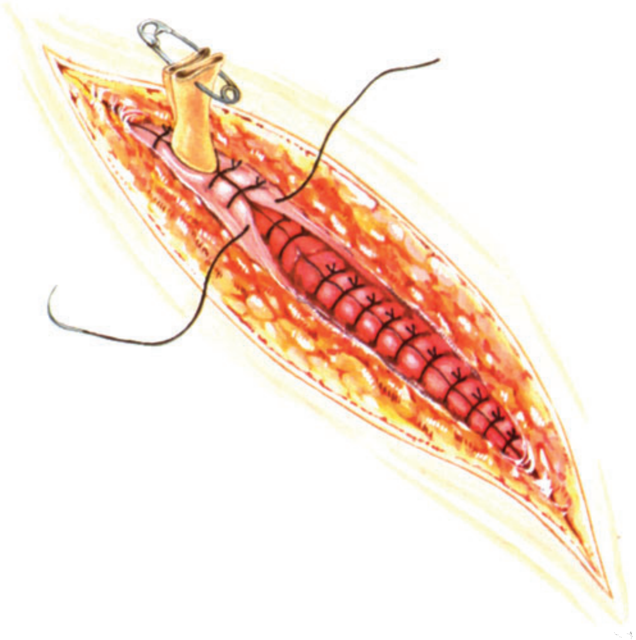
4-5. Prior to closure, a Penrose drain is inserted and secured in the renal fossa to permit drainage in the event of untoward sequelae. The drain can be removed in 24 hours. A routine nephrectomy without spillage does not require a Penrose drain. *The muscles are reapproximated with interrupted 0 chromic catgut.* The fascia is closed with interrupted 1-0 nylon. The drain is removed after an interval of 24–36 hours.



4-3



4-4



4-5

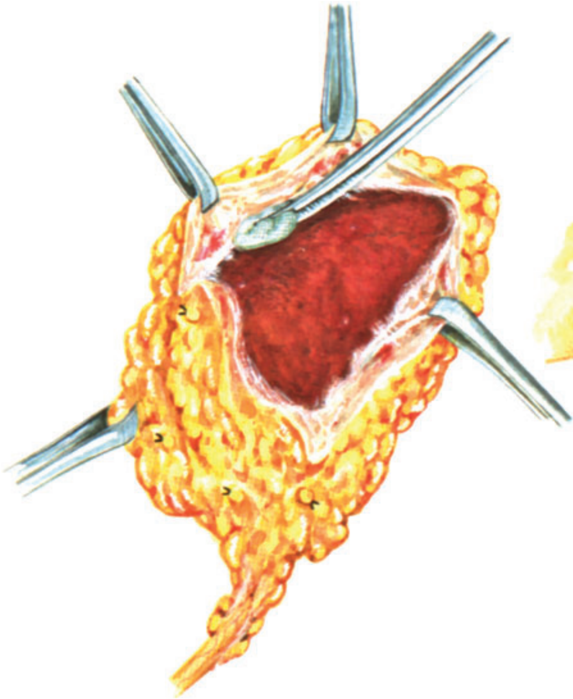
5. Subcapsular Nephrectomy

The kidney is depicted outside the operative field for clarity.

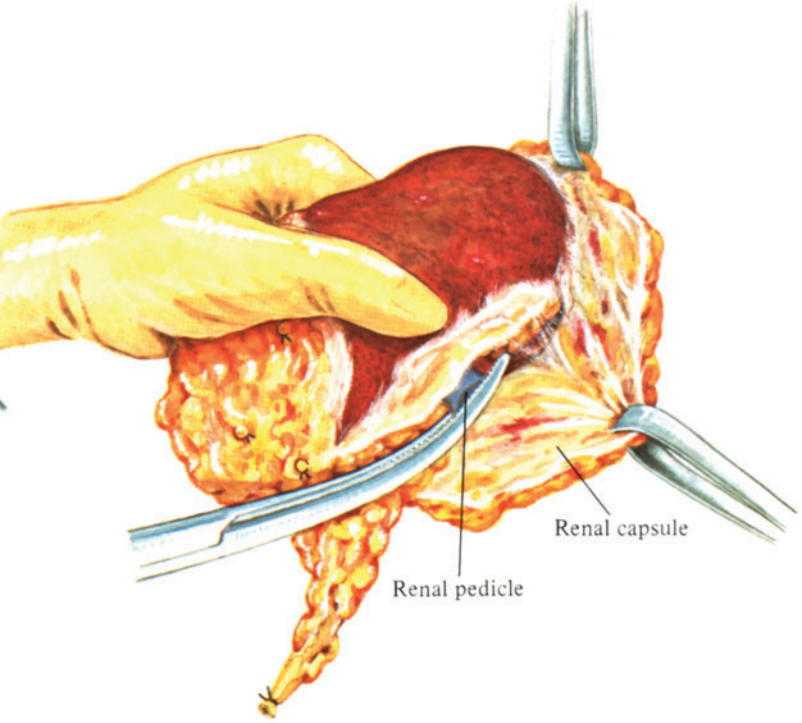
5-1. A subcapsular nephrectomy is performed since the kidney is immobile and adherent to surrounding fascial structures. *The anterior renal capsule is removed* to allow further dissection.

5-2. *The renal hilus beneath the capsule is exposed to allow a pedicle clamp to engage the renal vessels.* The renal pedicle is doubly ligated before the vessels are transected beneath the capsule. The ureter is isolated, ligated, and tied.

Final kidney removal is best accomplished by sharp dissection through fascial investments but avoiding the proximal renal pedicle.



5-1



5-2

6. Standard Partial Nephrectomy

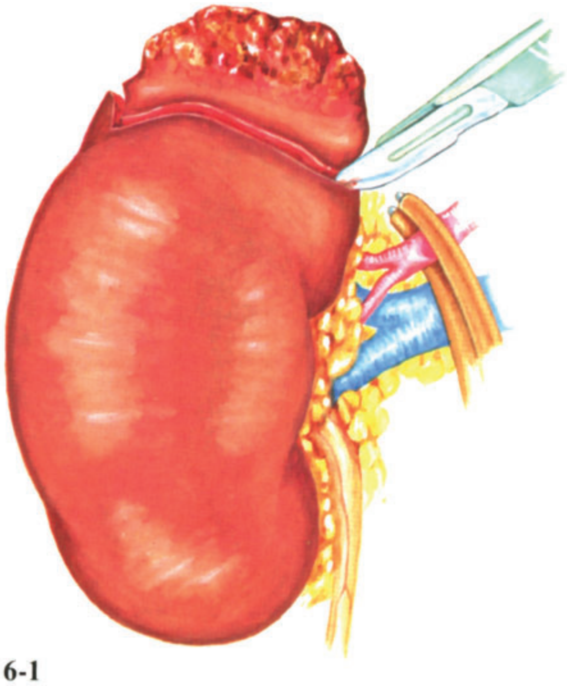
In the following sequences, the left kidney is exposed through a lumbar-flank approach.

6-1. The left renal artery lies posterior and slightly superior to the renal vein. *A vascular clamp is used to interrupt arterial blood flow* temporarily. The kidney is shown raised from the operative field. A circumferential incision is made at least 1.5 cm from the diseased margin. A frozen section of the border can be useful in determining the margin of clearance if necessary. Bleeding from the free parenchymal edge is reduced because of the vascular clamp on the renal artery. Regional cooling (15°C) of the kidney (see Fig. 8-3) can prolong the period of functional preservation up to approximately 2 hours. A kidney should not remain ischemic at normal temperatures beyond 20–30 minutes. Intermittent clamping may extend the safe period for another 20 minutes.[17]

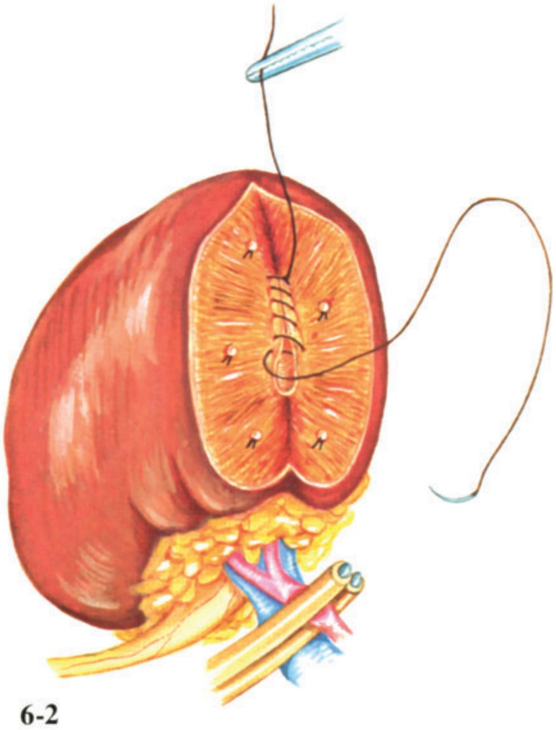
6-2. *During closure of the caliceal structures, hemostatic figure-of-eight sutures with 4-0 chromic catgut are used.* Bleeding points are located by intermittent unclamping of the renal artery.

6-3. *Closure of the renal capsule is accomplished by using mattress type sutures* (3-0 chromic catgut).

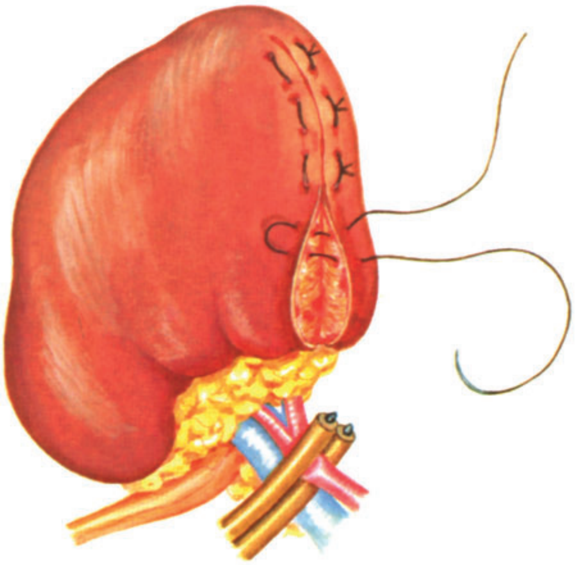
6-4. If bleeding persists after closure, *a deep through-and-through suture (2-0 chromic catgut) can be used to obtain hemostasis.*



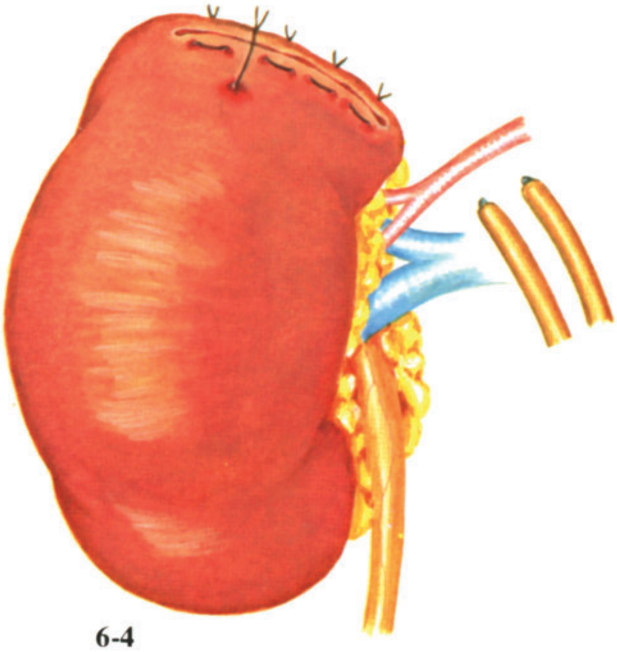
6-1



6-2



6-3



6-4

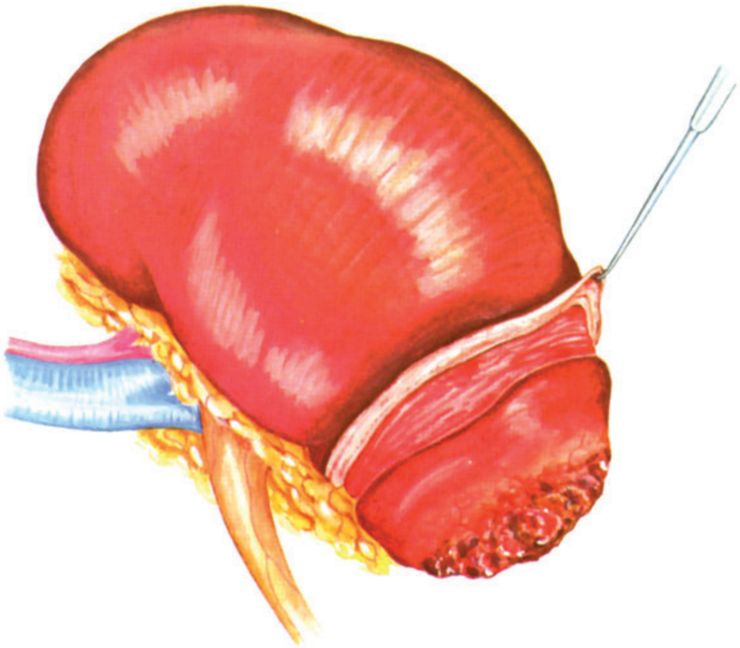
7. Tie Technique for Partial Nephrectomy

In the following sequence, the left kidney lower pole is exposed through a lumbar flank approach. The tie technique permits rapid removal of the diseased segment; renal arterial clamping is usually not necessary. Exposure of the renal artery however is important.

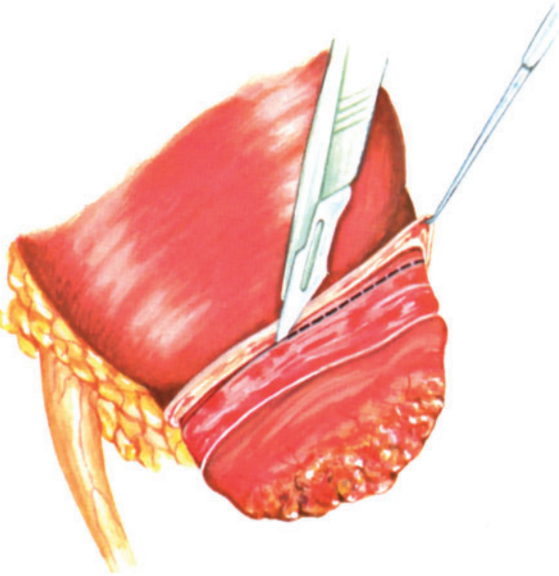
7-1. *A circumferential incision is made through the renal capsule* 1.5–2 cm distal to the diseased margin. The proximal margin of the renal capsule is carefully peeled back to expose the tie area.

7-2. *A superficial circumferential incision is made.*

7-3. *A noose with a half tie* (No. 1 nylon) is secured directly into the circular, superficial incision area.



7-1



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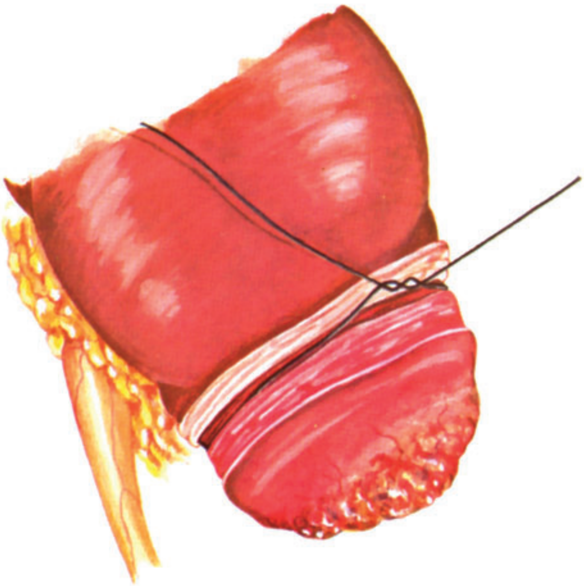
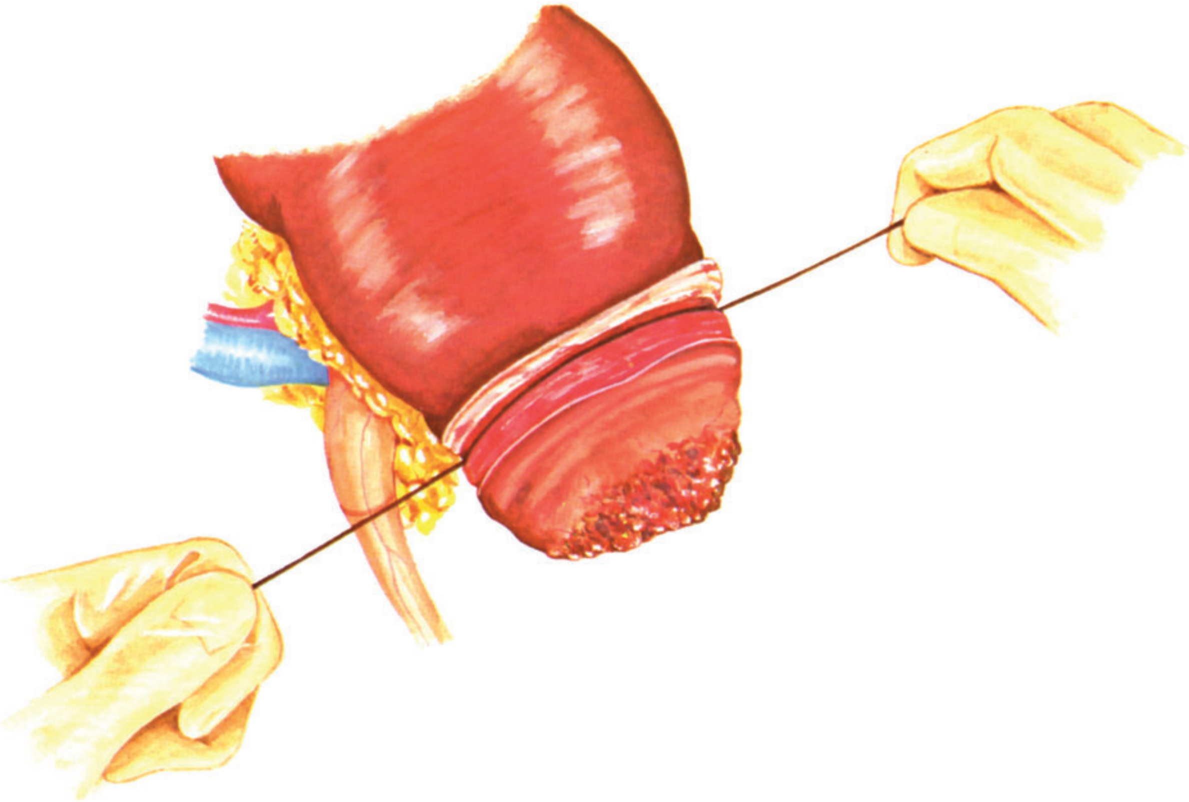


7-3

7-4. *The noose is tightened* until a core of parenchymal tissue measuring approximately 1.5 cm remains; it is finally secured.

7-5. *The diseased parenchyma and its free margin are excised by sharp* dissection, taking care to leave a small portion of ligated parenchymal stump.

7-6. *The base of the stump is secured with a suture ligature* (1-0 chromic catgut). It is then grasped and elevated by a surgical clamp.



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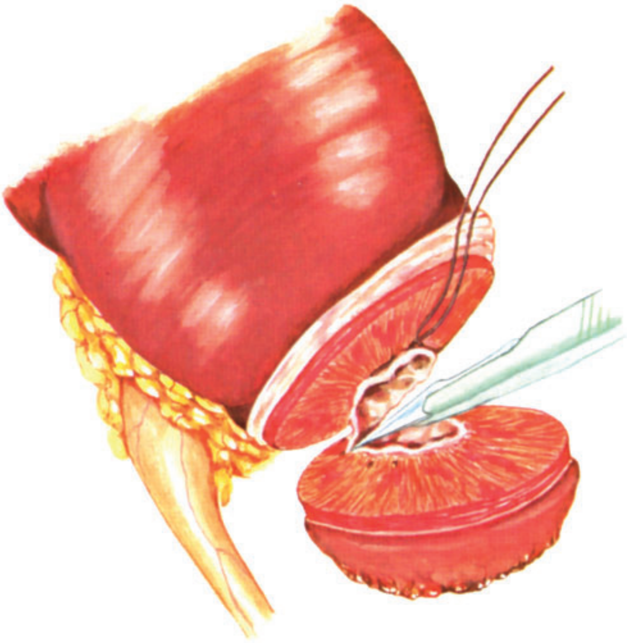

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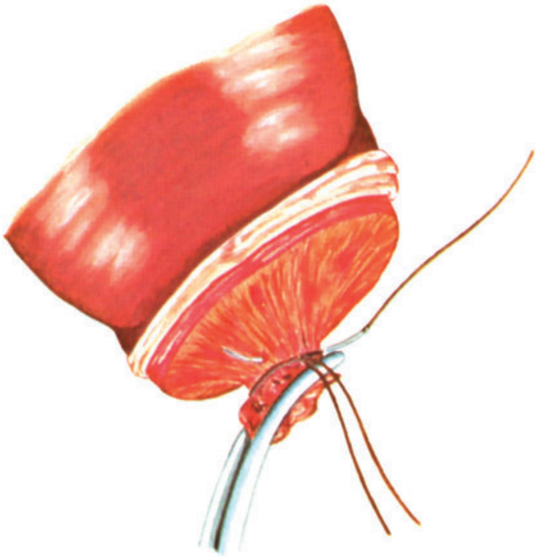


7-6

7-7. After the distal stump is excised, *the original noose will fall free or is removed.* If necessary, hemostasis can be further secured by individual suture ligatures (4-0 chromic catgut).

7-8. *The renal capsule is reapproximated* after any redundant tissue has been removed.

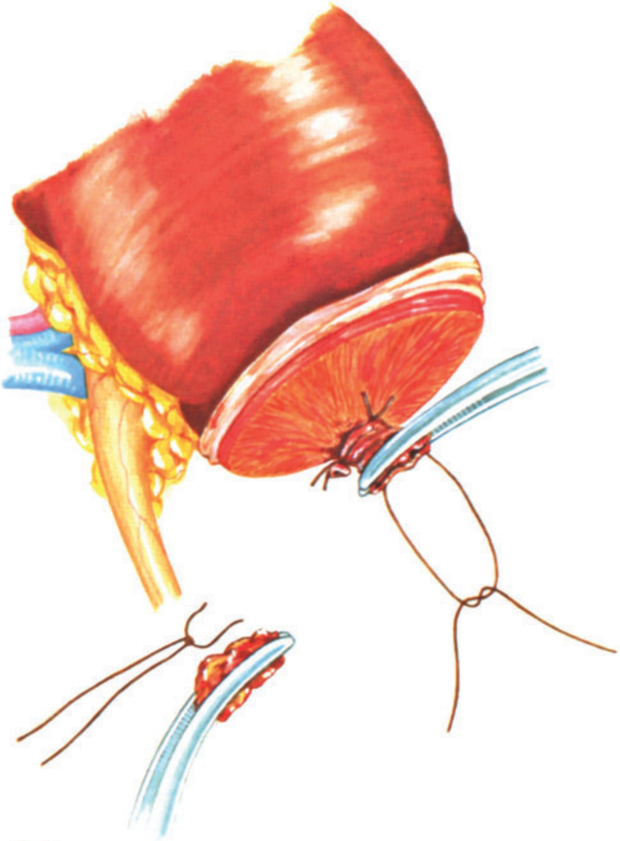
8. Segmental Nephrectomy Using Cooling Apparatus

In the following sequence a left solitary kidney (lower pole) is exposed through a lumbar flank approach. The cooling device shown is available in two half or four quarter pieces for operative convenience.

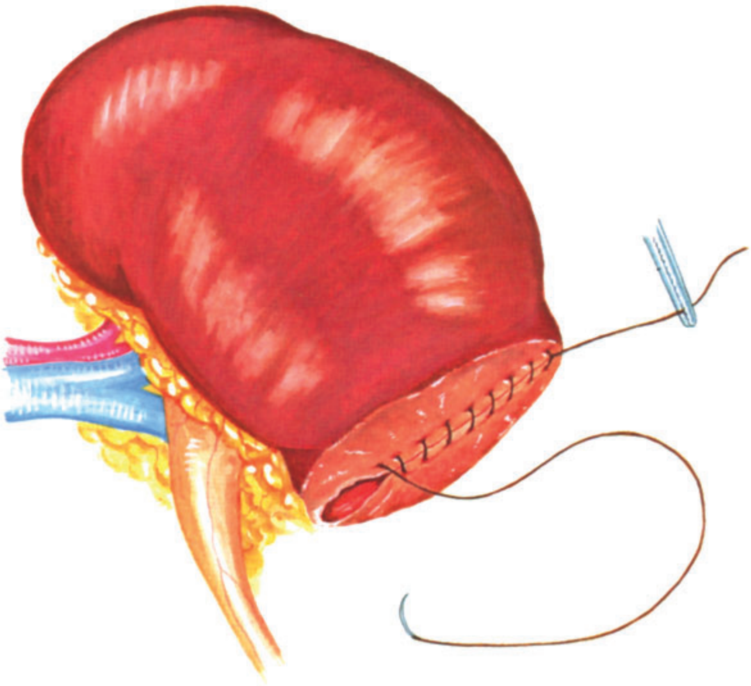
Case Report A 68-year-old white female (LW) underwent, in 1973, a partial left nephrectomy for a renal adenocarcinoma in a solitary kidney. In April 1968, she had undergone a right nephrectomy for adenocarcinoma. She was accordingly seen for follow-up several times a year. An interval intravenous pyelogram in 1971 was not remarkable. Her admission in 1973 was prompted by the occurrence of left flank pain and gross, painless, total hematuria.

Physical examination was unremarkable except for a blood pressure of 170/80 and left flank tenderness. She was anemic (hematocrit 29.5). Serum creatinine was 2.7 mg/dl.

Diagnostic X-ray studies were obtained. An intravenous pyelogram revealed a mass lesion in the lower left renal pole. A renal arteriogram demonstrated a 3-cm lesion with neovascular markings. The tumor area was abnormally vascularized by an inferior branch of the renal artery. A retrograde pyelogram confirmed the presence of a tumor. In March 1973 the patient was explored through a flank incision with removal of part of



7-7

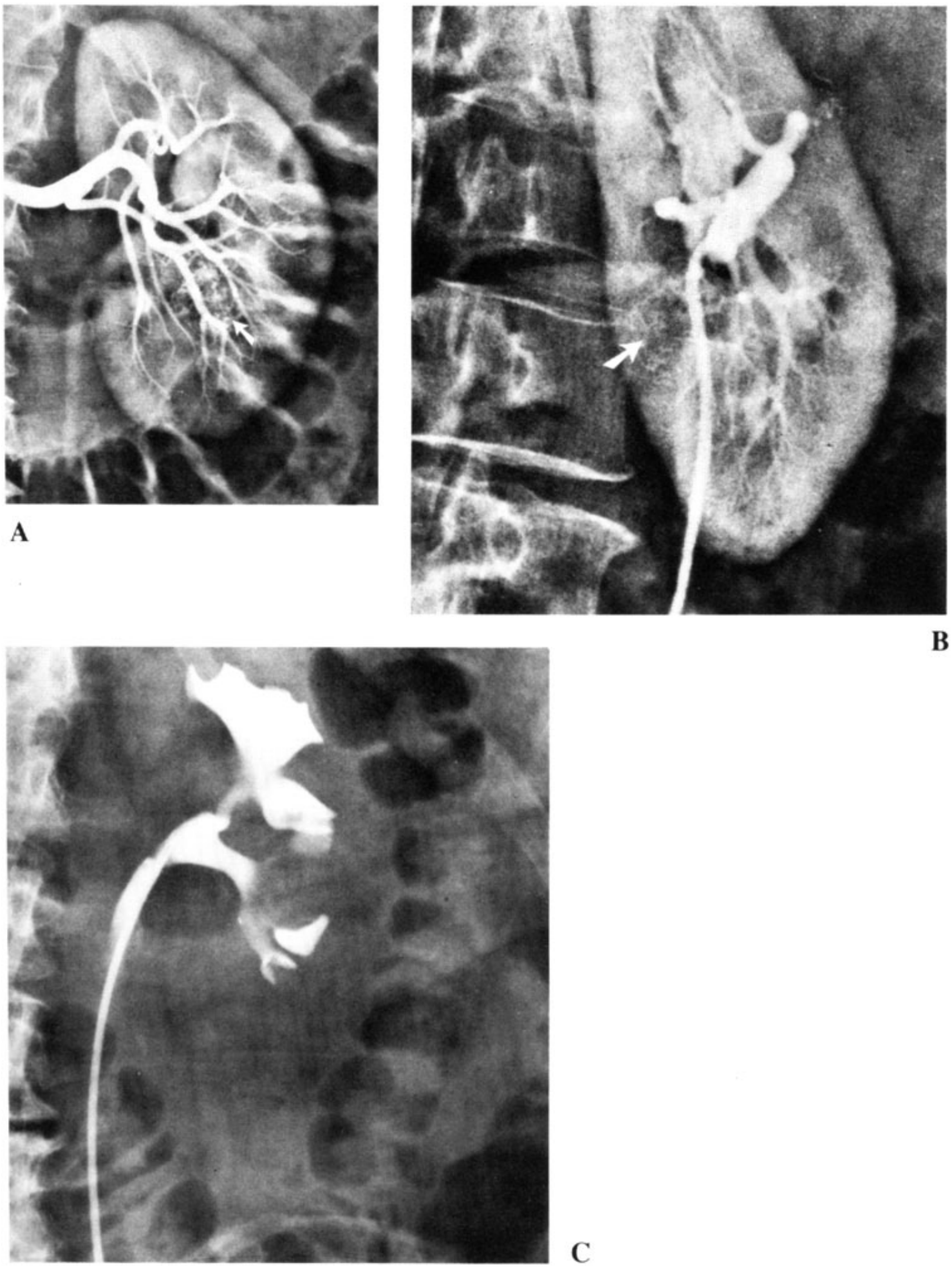


7-8

the 12th rib. The posterior surface of the kidney was exposed. Methylene blue was injected into the posterior inferior arterial branch supplying the tumor. This procedure demarcated the immediate borders for excision. The patient's renal vessels were isolated with tapes. The renal hypothermic apparatus was applied over the kidney surface prior to clamping of the renal artery. Hypothermia of the kidney (10° C) was achieved in the ischemic kidney.

The tumor and a border of normal tissue was removed. The patient's postoperative course was uneventful during the first week. Careful fluid management obviated the possible need for acute hemodialysis. She was discharged on the 26th postoperative day with a serum creatinine of 2.9 mg/dl.

The patient's serum creatinine levels during the past 5 years have varied between 2.4 and 2.9 mg/dl. Her most recent study in March 1977 revealed a creatinine of 2.9 mg/dl. No evidence for tumor recurrence has been noted.

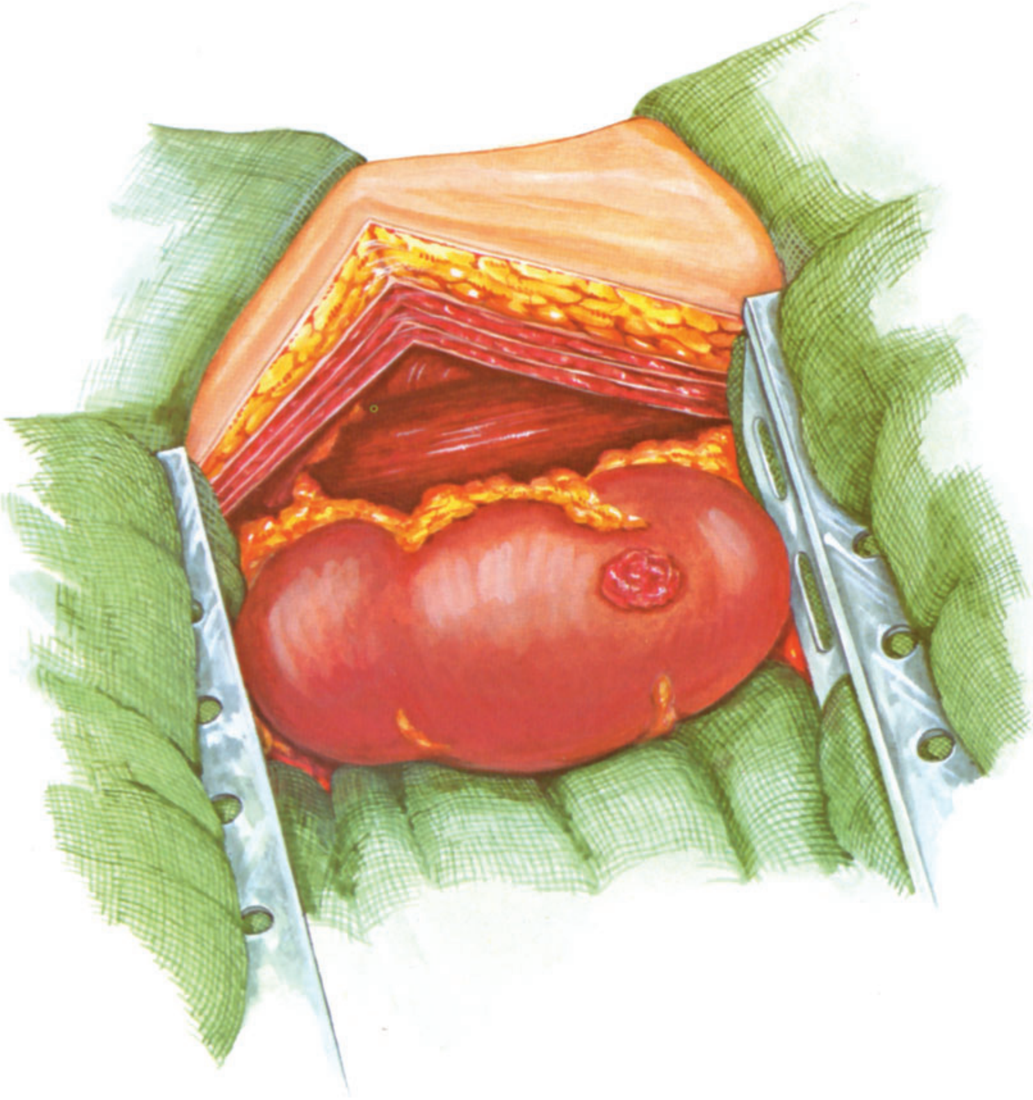


8-1. *The posterior surface of the left kidney is exposed,* showing extension of the lesion on the surface.

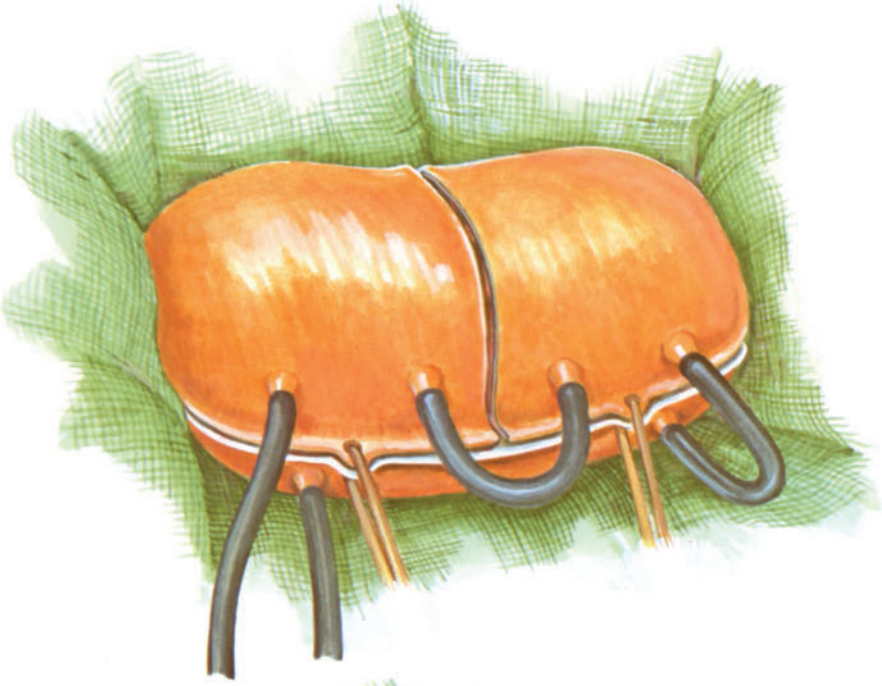
8-2. *The cooling apparatus is in situ.*

8-3. *The kidney's upper half is undergoing cooling* (10° C). Blood flow to the renal artery has been interrupted temporarily with a vascular clamp to facilitate cooling.

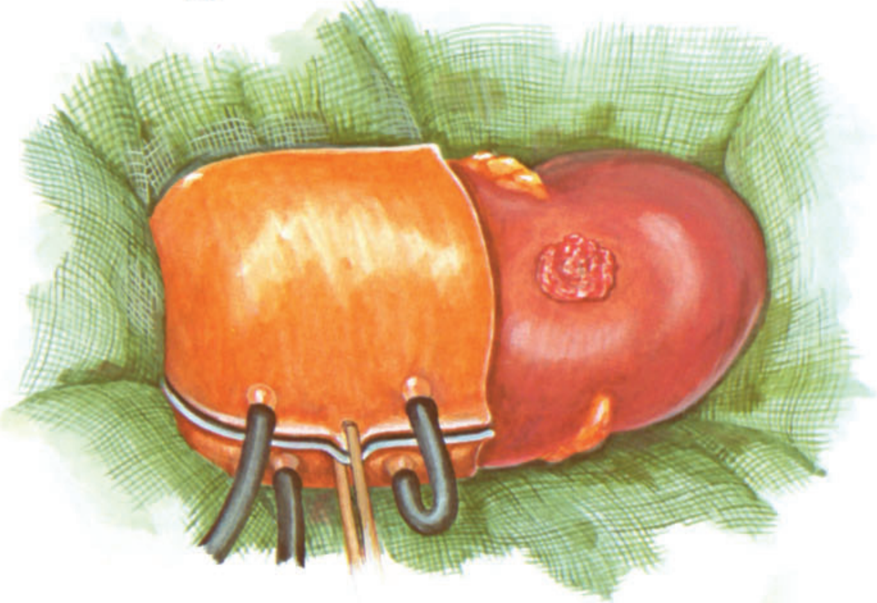
8-4. *The neoplasm is excised* beyond the area of visible lesion. A margin of 1.5–2 cm is maintained. Individual hemostatic suture ligatures are necessary to control bleeding. Bleeding points are found by intermittently unclamping the renal artery. A portion of the calices and pelvis is removed in this excision; the edges are reapproximated before closure (4-0 chromic catgut). However, in this patient the renal parenchyma was left exposed.



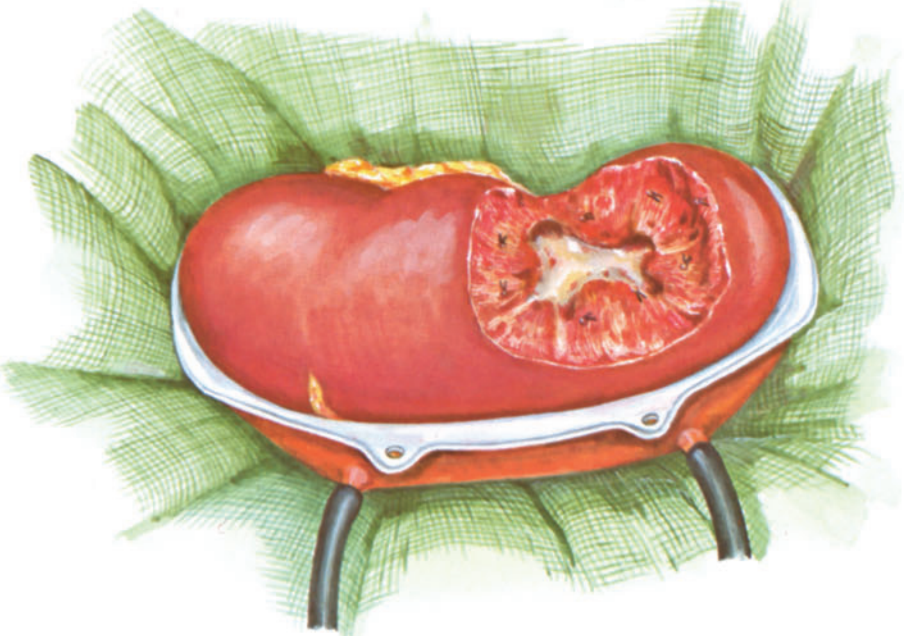
8-1



8-2



8-3



8-4

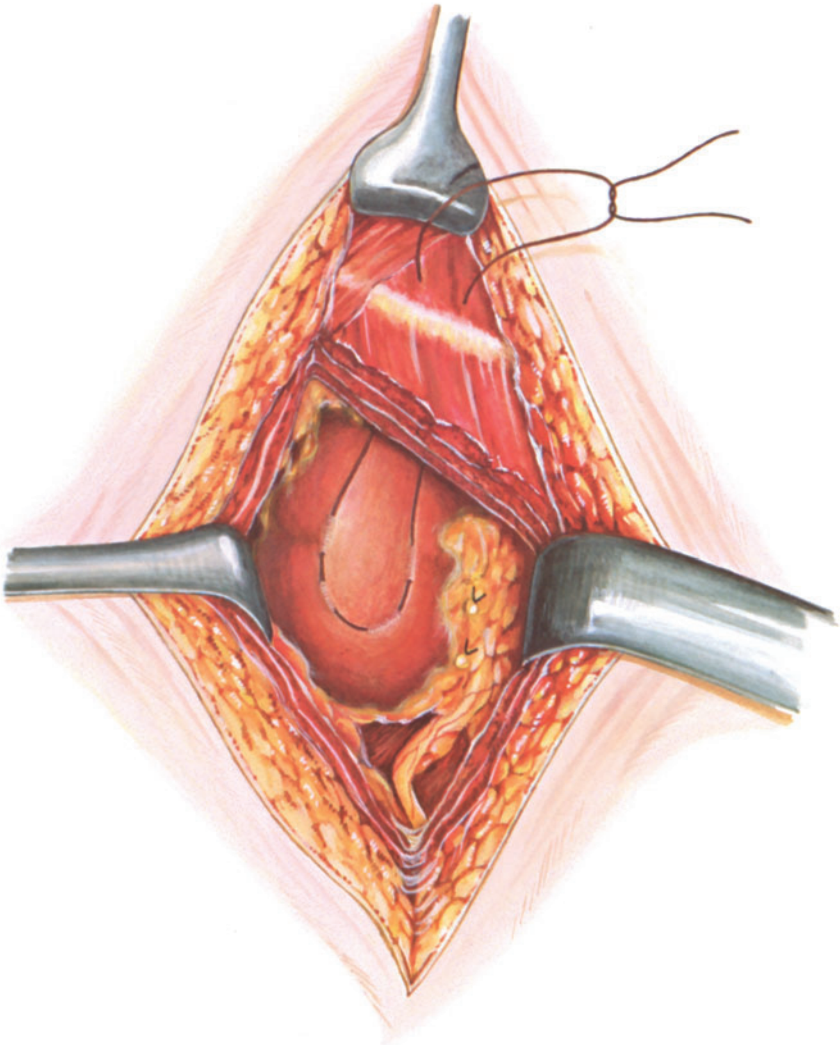
9. Nephropexy

Patient selection for nephropexy should be carefully considered. Renovascular hypertension secondary to nephroptosis or renal obstruction on standing are two indications for this surgical procedure. A vertical incision is preferred.

9-1. *Muscle layers are severed* to expose the anterior lower two-thirds of the right kidney. A suture 2-0 chromic catgut is passed intermittently into the capsular tissue. Both free ends are passed beyond the eleventh rib and tied over the muscles as seen.

9-2. *Modified nephropexy procedure of Deming.*[7] Additional support is achieved by reapproximating the fascial attachments inferior to the kidney.

9-3. *Final skin closure is accomplished.*



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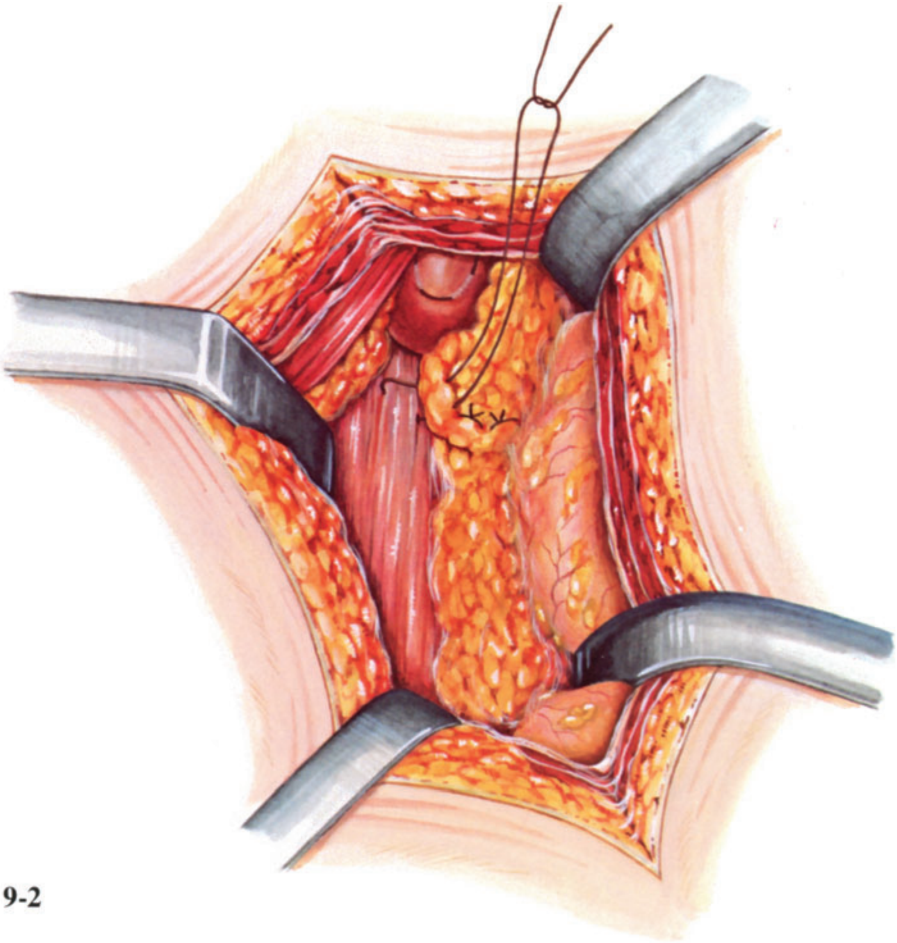


9-2

9-3

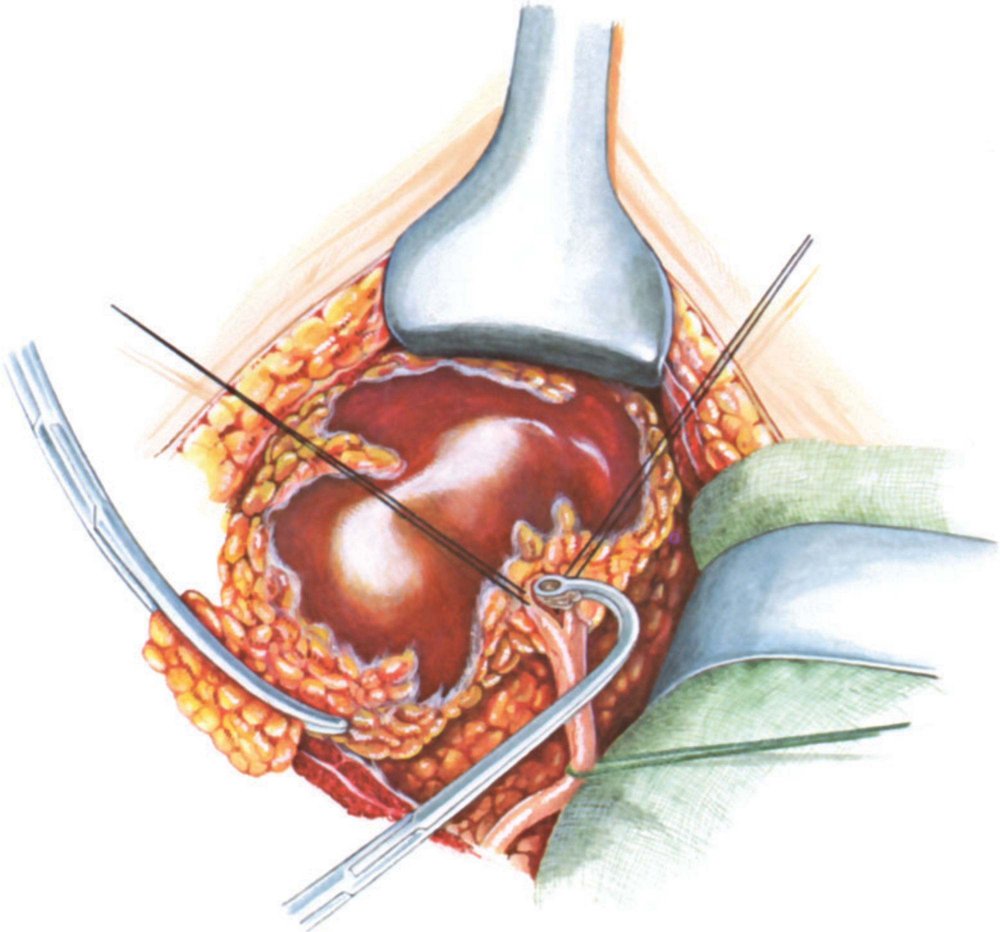
10. Pyelolithotomy

For extrarenal pyelolithotomy, the renal pelvis of the right kidney is approached anteriorly through a transabdominal incision. We have generally obtained superior preoperative and operative X-ray films of the kidney with the patient in the supine position.

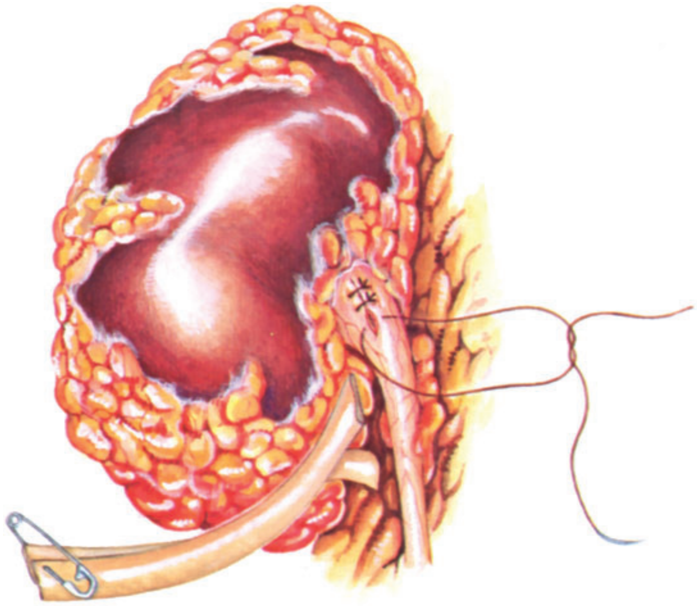
10-1. *Stay sutures expose the ureteropelvic junction.* A Randall's stone forceps is inserted to remove the calculus. The kidney is maintained in the operative field by gentle traction of the fascial attachments at the lower pole.

10-2. After removal of the calculus it is advisable to insert an 8 French red rubber ureteral catheter to wash out small residual stones and debris. An X-ray film taken at this time can be useful. A second ureteral catheter (5 or 6 French) is inserted inferiorly and passed into the bladder (20–23 cm). The purpose of this maneuver is to rule out the possible presence of a stony fragment that has migrated at the time of manipulation. *Ureteral reapproximation is accomplished by periadventitial sutures* (4-0 chromic catgut). *Two Penrose drains are secured in place.*

10-3. A cross section. The *stone forceps is used to grasp a calculus* lodged in a major calix. This maneuver is more easily accomplished with the patient in a supine position or with the anterolateral area over the kidney elevated.



10-1



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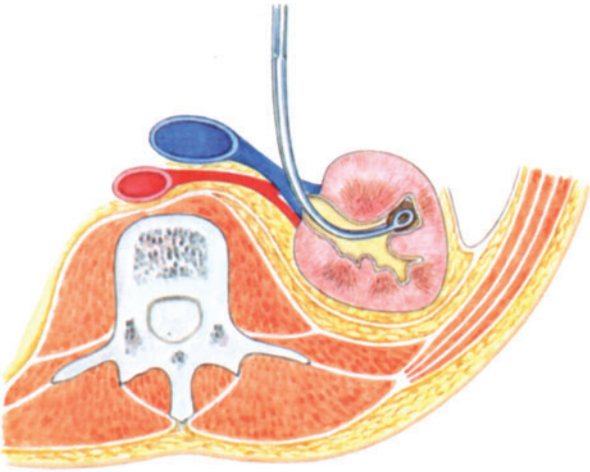


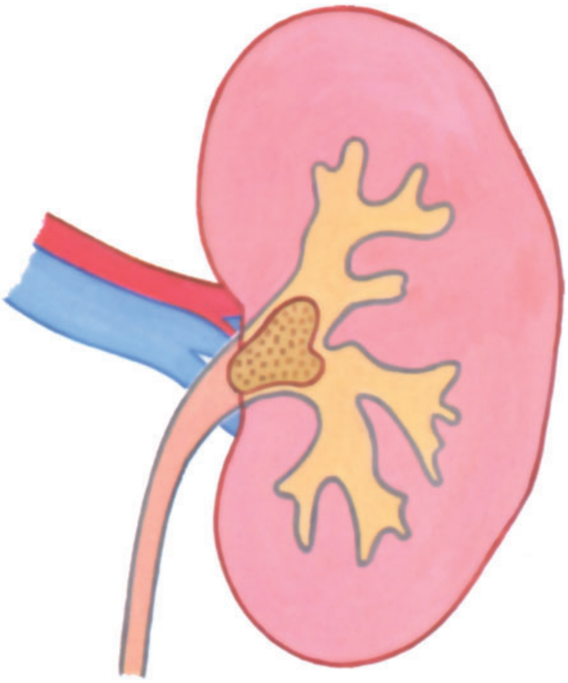
10-3

Intrarenal Pyelolithotomy

In the following sequence, two techniques are described to remove the calculus.

11. Gil-Vernet Technique[10]

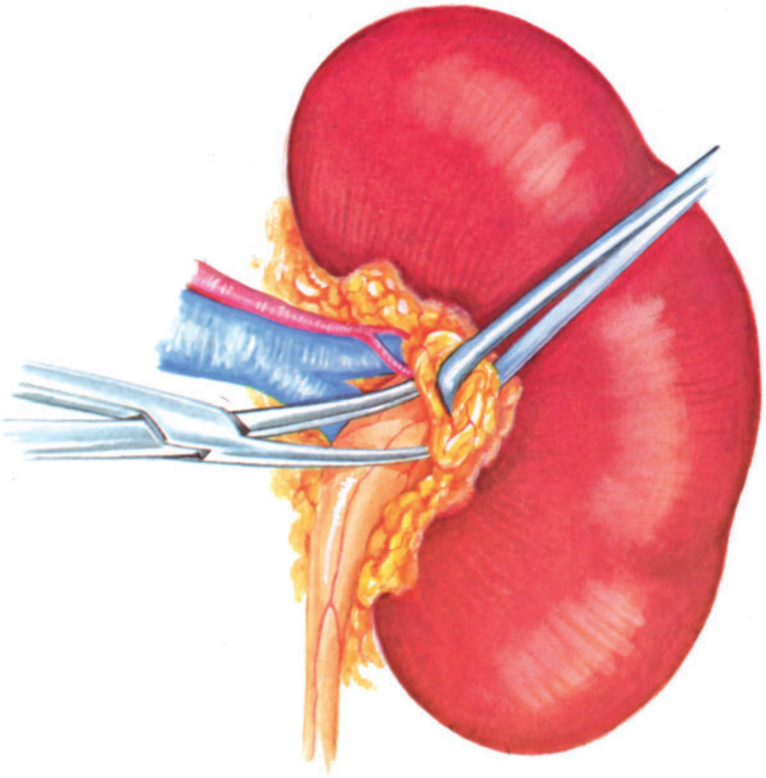
11-1. *A moderate-sized calculus is lodged in the intrarenal pelvis of the right kidney.*



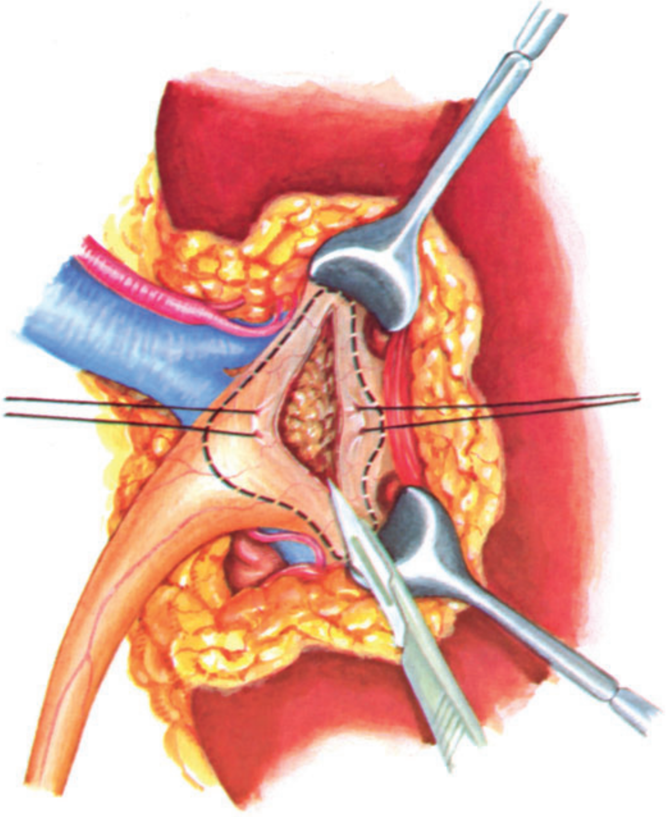
11-1

11-2. A standard incision is made to approach the posterior right kidney. In this instance *a flank incision and dissection exposes the renal pelvis.* A posterior dissecting plane is developed between the pelvis and the renal hilus. The renal artery is isolated but not clamped.

11-3. Blunt dissection between posterior pelvis and renal hilus is continued within the kidney to allow significant *exposure of the pelvis and major calices.* Special long-handled retractors (similar to vein retractors) are useful to expose this surgical field (*dotted line*). Stay sutures are inserted for exposure of the pelvis. The incision in the pelvis is made and the calculus can now be removed. Catheter irrigation (8 French) is useful to remove debris. A ureteral catheter is passed inferiorly into the bladder. Stay sutures are removed. Standard closure of the pelvis is performed. As a standard precaution a Penrose drain is placed near the pelvis and secured for 3–5 days before shortening it.



11-2



11-3

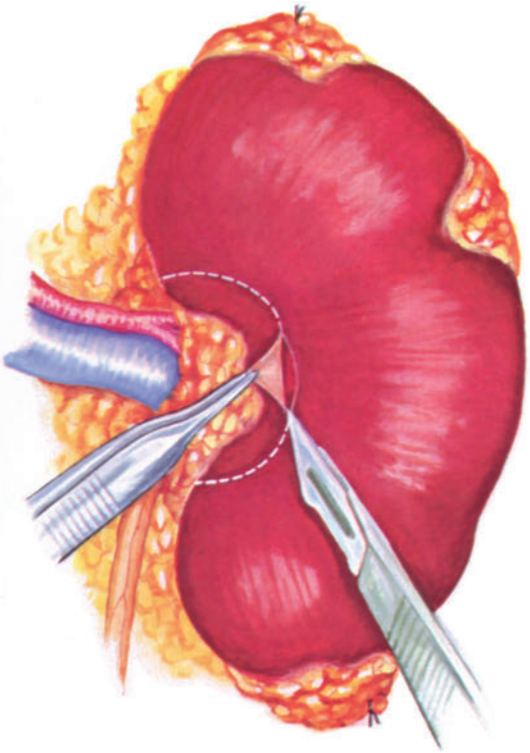
12. Subcapsular Technique

12-1. An alternative operative approach to the posterior right kidney is similar to that described in the Gil-Vernet method above.[8] The *dotted line depicts the line of incision through the renal capsule.*

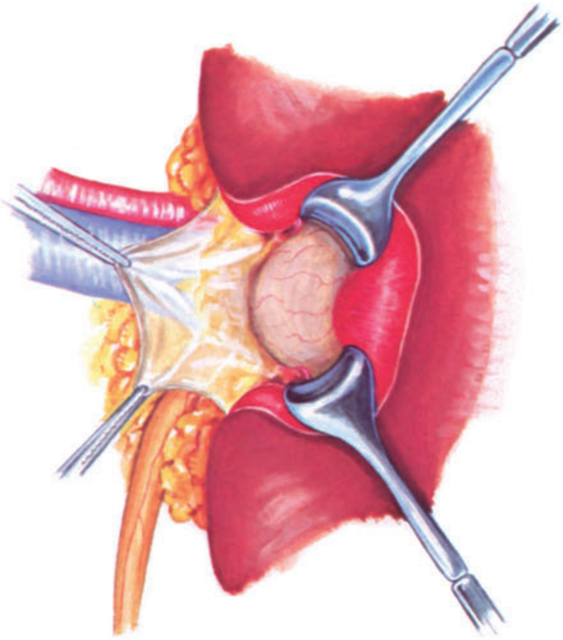
12-2. *The capsule is incised and peeled* back exposing the intrarenal pelvis. Vein retractors help to expose the surgical field.

12-3. *Stay sutures are placed in the renal pelvis.* An incision is made into the lumen of the pelvis.

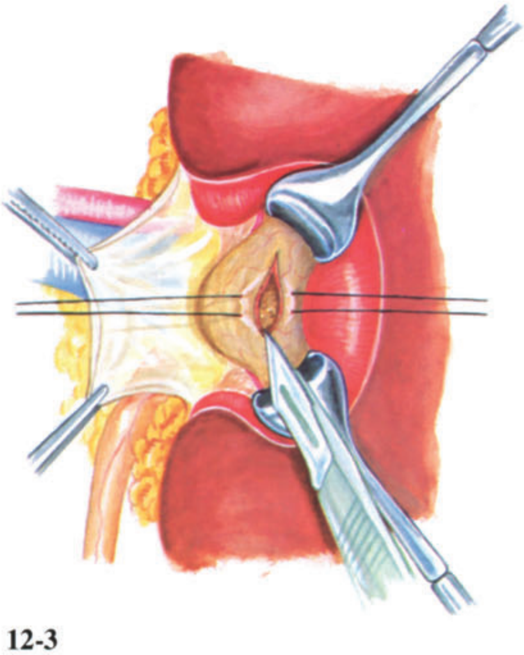
12-4. *The calculus is removed.*



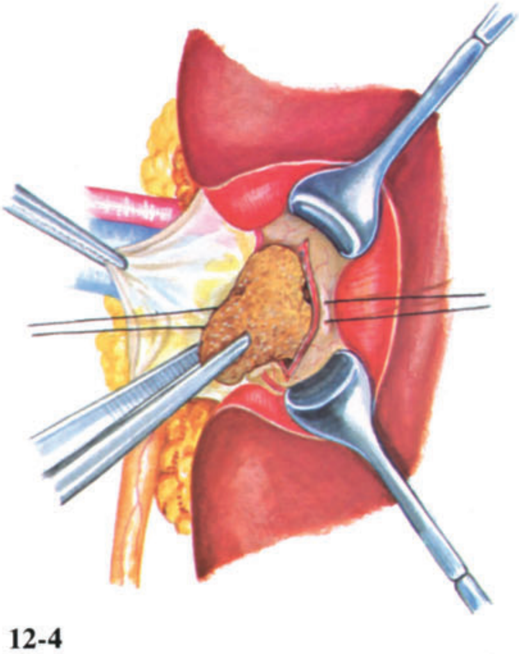
12-1



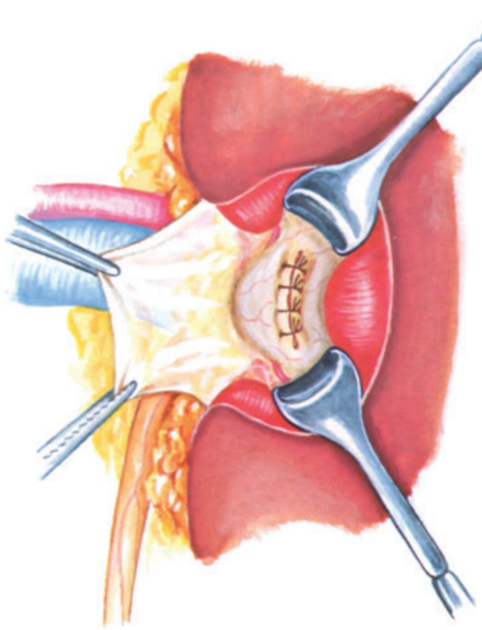
12-2



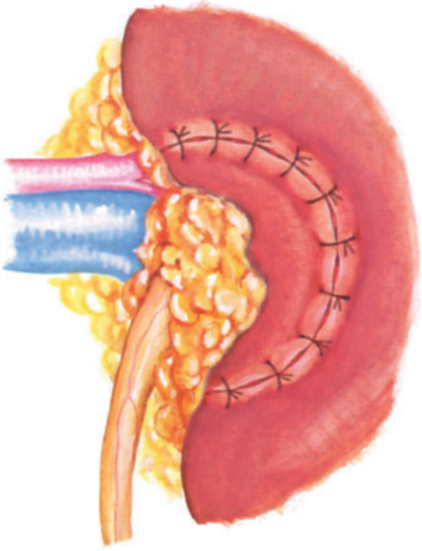
12-3



12-4



12-5



12-6

12-5. Before closure, catheter irrigation is performed within the pelvis. *A ureteral catheter is passed inferiorly to the bladder.* Standard closure of the pelvis is performed.

12-6. *The renal capsule is reapproximated.* A Penrose drain is inserted prior to closure of muscle and skin.

13. Combined Pyelolithotomy–Nephrolithotomy

In the following sequence, a technique for a stone lodged in a major calix is demonstrated. A standard incision is made to approach, in this case, the left kidney (anterior transabdominal technique).

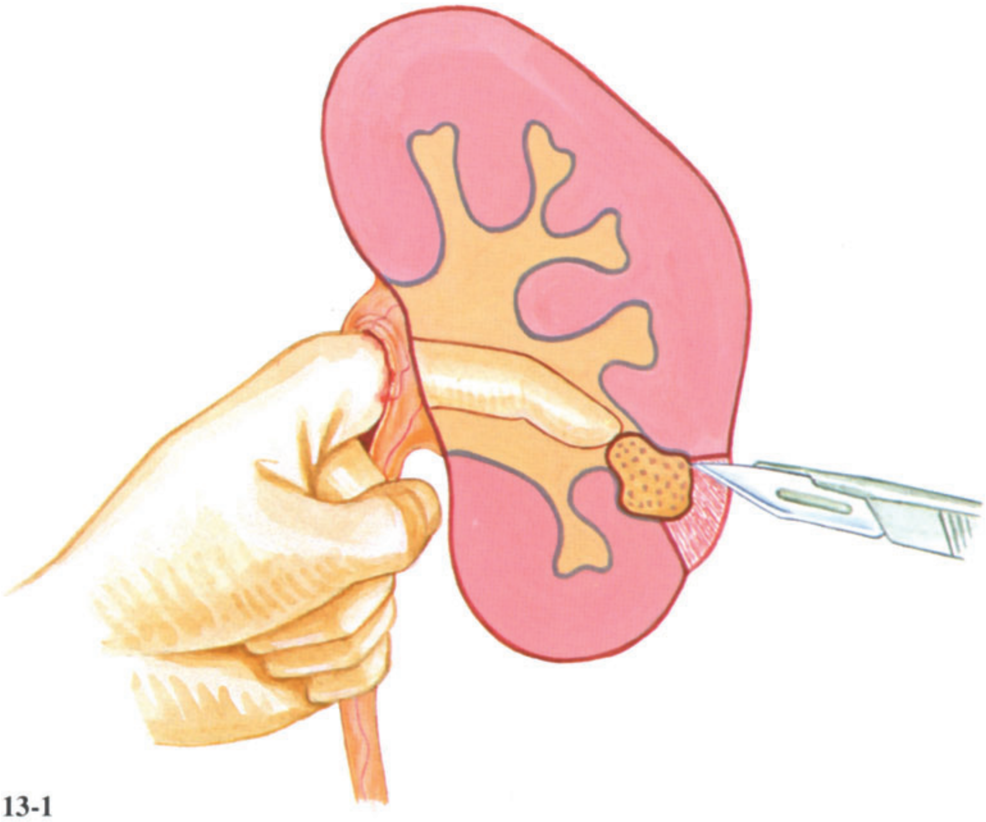
13-1. *Extrarenal pelvic insertion of the index finger immobilizes the stone by pressure.* In certain instances a Randall's stone forceps can be substituted for the finger.

13-2. *The calculus is readily removed from the incision site.* Through-and-through irrigation is performed.

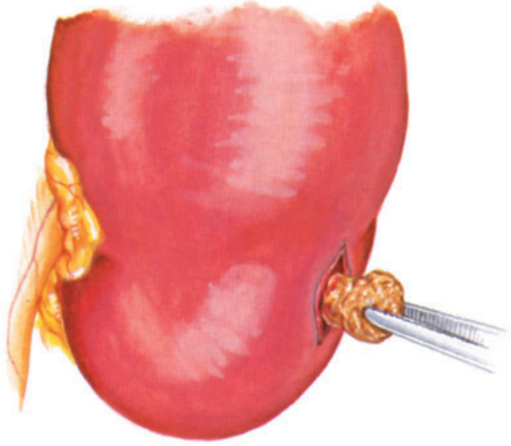
13-3. For kidney closure, *insertion of a nephrostomy tube may be indicated,* e.g., pyeloplasty or nephrolithotomy. We favor the use of a red rubber straight Robinson catheter (16–22 French). Extra holes are cut in the end of the catheter remaining in the renal pelvis.

We have had success with a simple atraumatic method for inserting the nephrostomy tube from skin opening through renal parenchyma, lower dependent calix and renal pelvis. The use of a male VanBuren sound, 16 French, with an opening previously drilled through its curved tip (Fig. A, p. 38) is helpful.

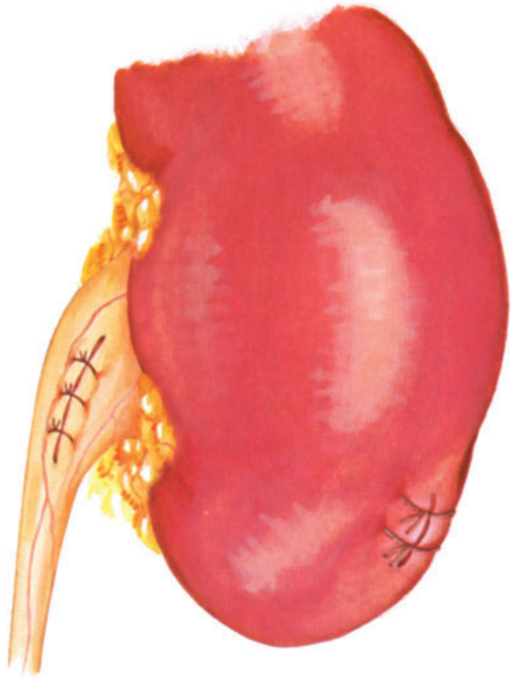
The tip of the sound is inserted through the renal pelvis and into the dependent calix. Gentle lifting of the sound will provide localization of the sound's tip at the periphery of the renal parenchyma. Only a small incision is required for the sound to be exposed at the renal periphery.



13-1

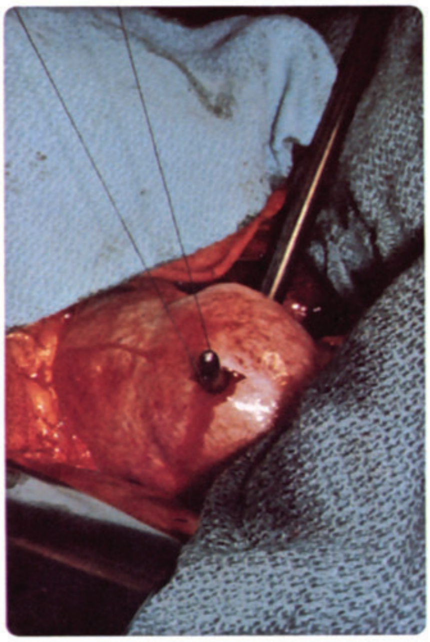


13-2

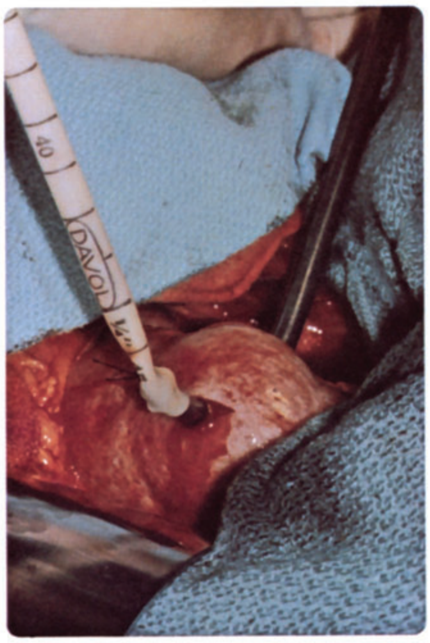


13-3

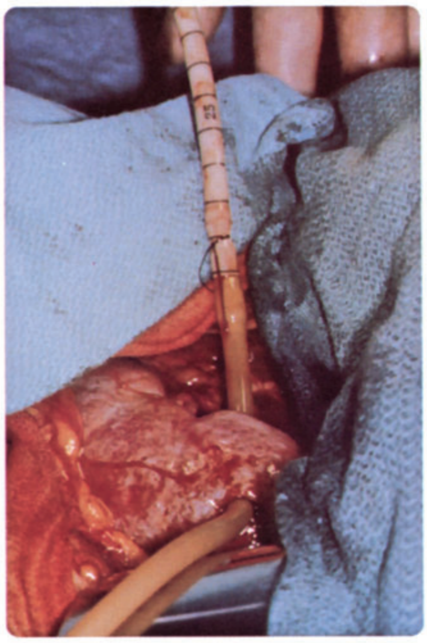
The tip of the nephrostomy tube is brought through a small flank stab skin incision and through muscle layers to a location adjacent to the exteriorized tip of the sound. The catheter tip is then inserted into the lumen of a small Penrose drain for a distance of 10–14 cm. If necessary, the eye of the catheter may be secured to the Penrose drain by a suture ligature. The other end of the Penrose drain is secured to the tip of the curved metal



A



B



C

sound by a suture ligature. The hole in the sound facilitates this step. The sound is withdrawn through the calix and out the renal pelvis by gently tugging the Penrose drain (Fig. B). Further tension on the drain will bring the nephrostomy tube atraumatically into renal pelvis. The Penrose drain on its distal tip surrounds the nephrostomy tube for 4 cm. The nephrostomy tube may now be secured to the renal capsule and skin margin at the stab wound.

14. Stone Removal with Endoscopic Instruments

A recent advance in urology has been the development of fiberoptic nephroscopes* similar to the one illustrated here. If diagnostic X-ray studies indicate multiple small calculi (2–4 mm diameter), this instrumental approach can be useful. Endoscopic viewing of the various calices is possible to locate shifting calculi. A standard anterior transabdominal or flank approach can be used. We favor the flank approach.

14-1. The renal pelvis is incised. Stay sutures are helpful to provide and maintain exposure. *The nephroscope and an additional irrigating catheter are inserted.* Note the need for an abdominal sucker.

14-2. *A nephroscope with dual irrigating system is used;* stone forceps are accommodated by the instrument.

14-3. *A midsaggital view of left kidney demonstrates endoscopic manipulation at multiple potential sites* containing renal calculi. Stone forceps are used via the flexible endoscope.

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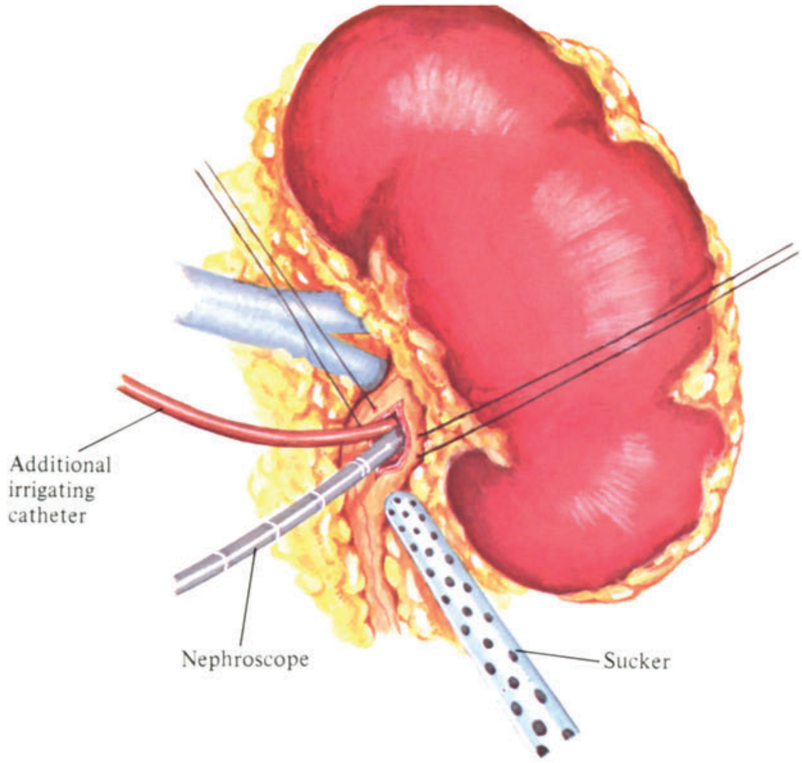
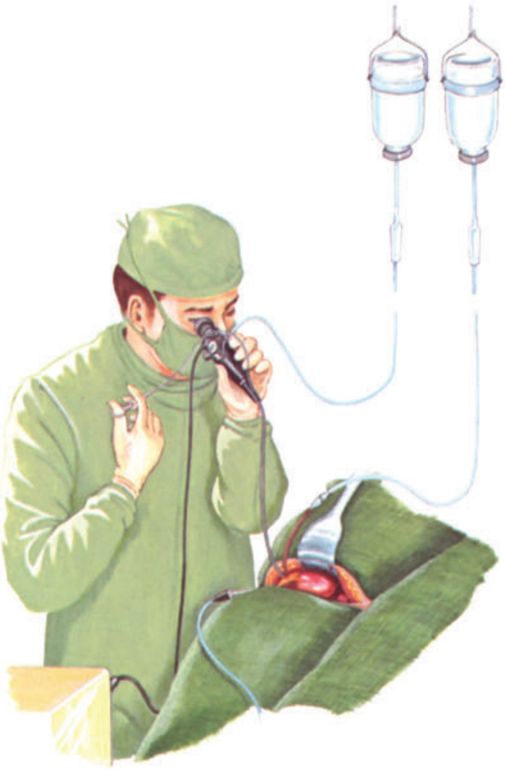
* Two Japanese Companies now manufacture the nephroscope that is depicted. They are Machida Inc., and Olympus Optical Company. Both have home offices in Tokyo, Japan. Branch offices are located in Closter, New Jersey (Machida) and New Hyde Park, New York (Olympus).

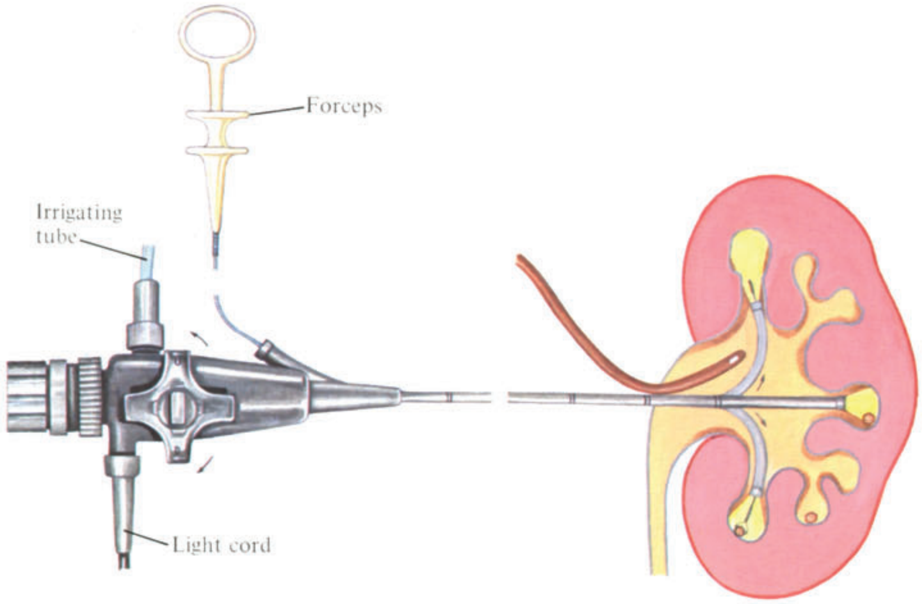
A choledochofiberscope, which can be used to extract gallstones from the common bile duct, is interchangeable as a nephroscope.


Additional
irrigating
catheter
Nephroscope
Sucker

14-1



14-2


Forceps
Irrigating
tube
Light cord

14-3

15. Removal of Staghorn Calculus

The preferred surgical approach for this procedure is the lumbar flank method (described earlier), because it provides satisfactory exposure of the kidney surface and posterior renal pelvis and easy access to the renal artery.

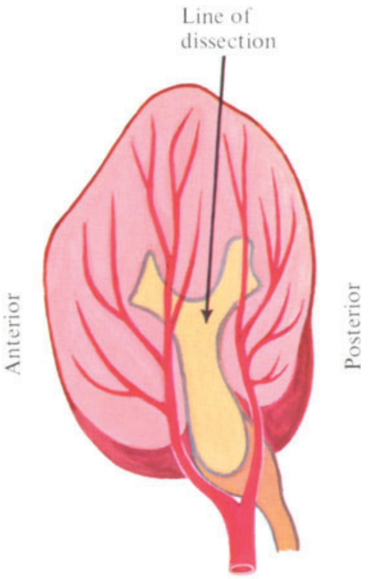
15-1. In the schematic showing the *preferred avascular line of incision,* there are two major branches of the renal artery, anterior and posterior. The small area of relative avascularity (*arrow*) is best determined at surgery by injecting 3 ml methylene blue dye into one major arterial branch. Boyce and Elkins[3] prefer the administration of 20 ml methylene blue injected intravenously. We believe the posterior or anterior arterial branch can be briefly occluded. A small 25-gauge needle with 3 ml dye can then be injected in the major renal artery branch (posterior or anterior).

15-2. After the kidney has been freed and lifted from its bed, *the renal artery is temporarily occluded with a vascular clamp.* Cooling of the kidney can be accomplished in several ways. We prefer the method and procedure described in Figs. 8-2 and 8-4. Other methods include the use of sterilized ice packs, refrigerated saline or sterile saline slush in a plastic envelope. On a rare occasion, frank removal of the kidney and "workbench" surgery may be elected by the surgeon. This requires renal artery perfusion of a hypothermic solution (7° C) to preserve function.[2] The ureter is not severed in this procedure.

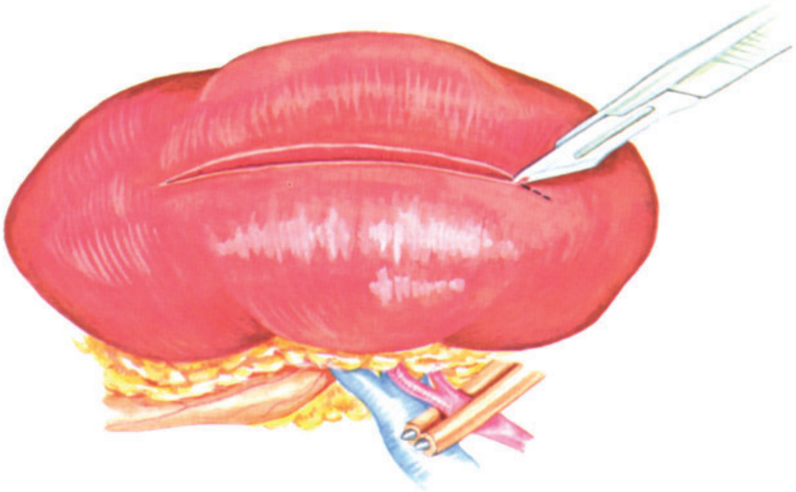
The following sequence of illustrations demonstrates the details of staghorn calculus removal by an intersegmental approach.

15-3. The *incision is extended* by blunt dissection *down to the surface tissue of the pelvis and calices.* The handle of the knife is used.

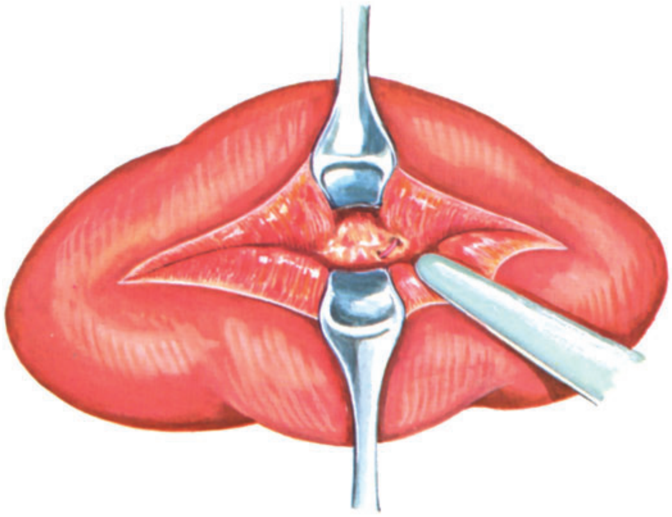
15-4. *Branches of the renal artery and vein* can be recognized and *are individually ligated.* The pelvis is entered between the anterior and posterior calices at the caudal end of the kidney. The peripelvic venous plexus is less well formed on this end.



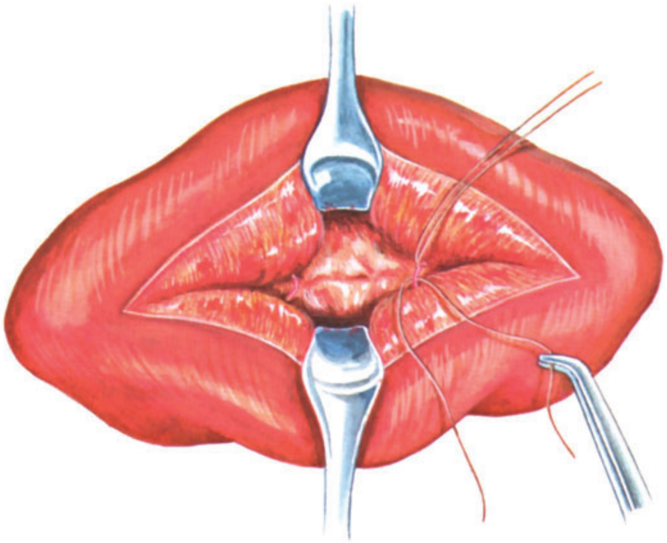
15-1



15-2



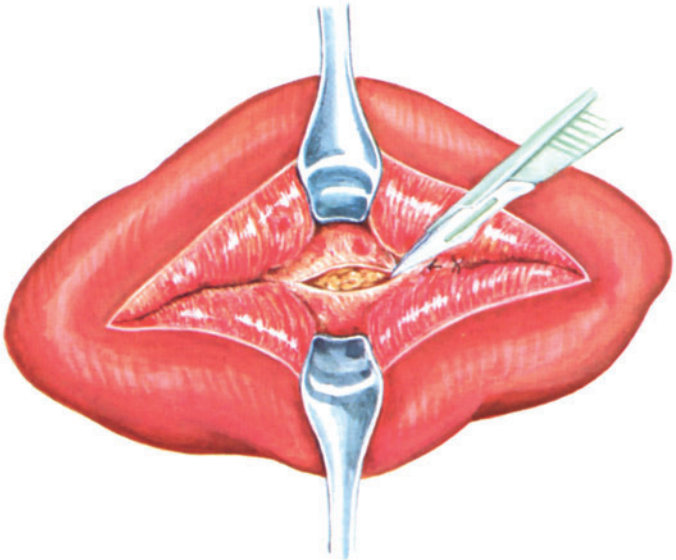
15-3



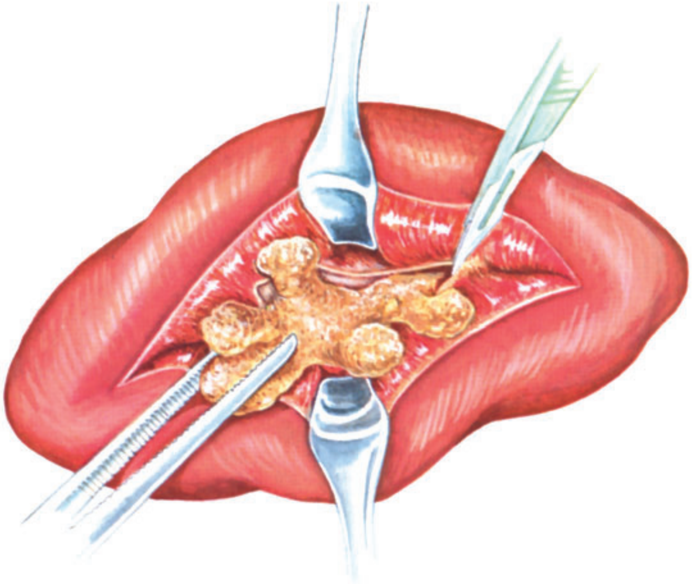
15-4

15-5. *The incision is* made and *gradually extended into the pelvis* to facilitate removal of the staghorn calculus. Each calix containing a branch of calculus is opened by extending the incision from the incised pelvis. The posterior calices are incised on their anterior surfaces, and if necessary, the anterior calices are opened on their posterior surface. All caliceal extensions are made in the transverse plane. This technique will generally avoid the transmedullary and interlobar arterial branches.

15-6. The calices are opened and dissected in a lateral and medial direction to allow *removal of the stone in a single piece.*



15-5



15-6

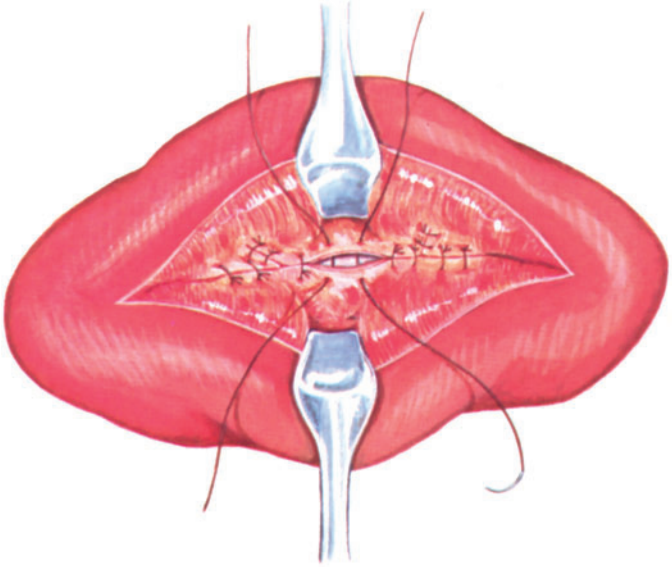
Closure

15-7. *Pelvic and caliceal closure is made with 5-0 chromic catgut.*

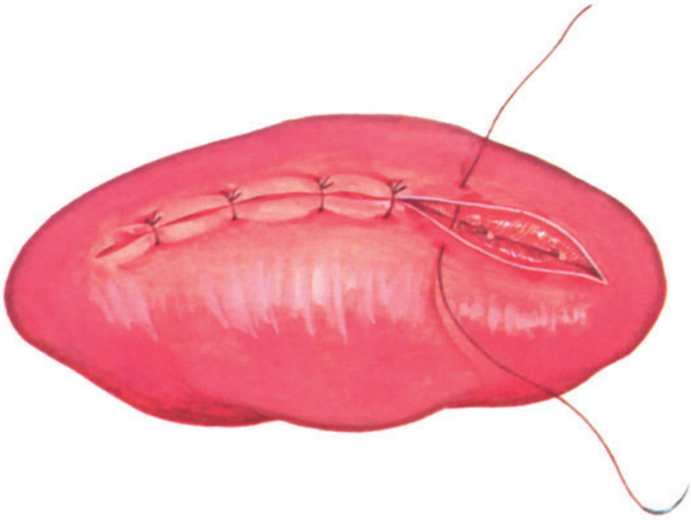
15-8. *The renal capsule is closed.*

15-9. *Continued vascular oozing can be controlled by one or more deeper sutures.*

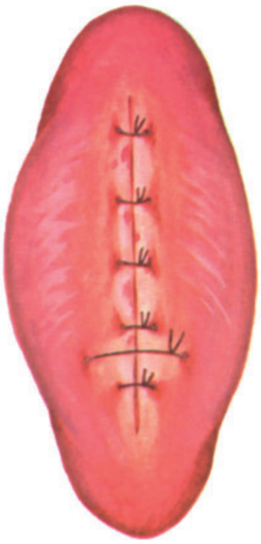
15-10. *A schematic clarifies internal details of the closure.*



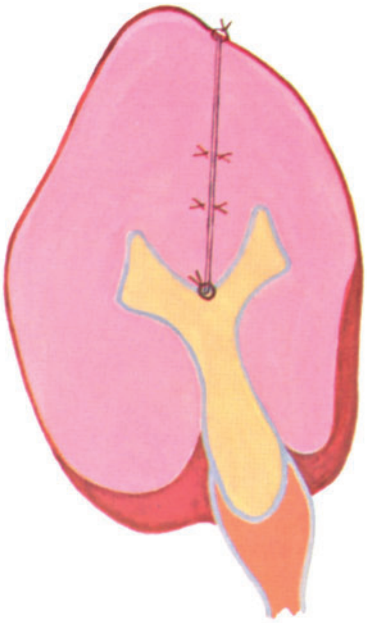
15-7



15-8



15-9



15-10

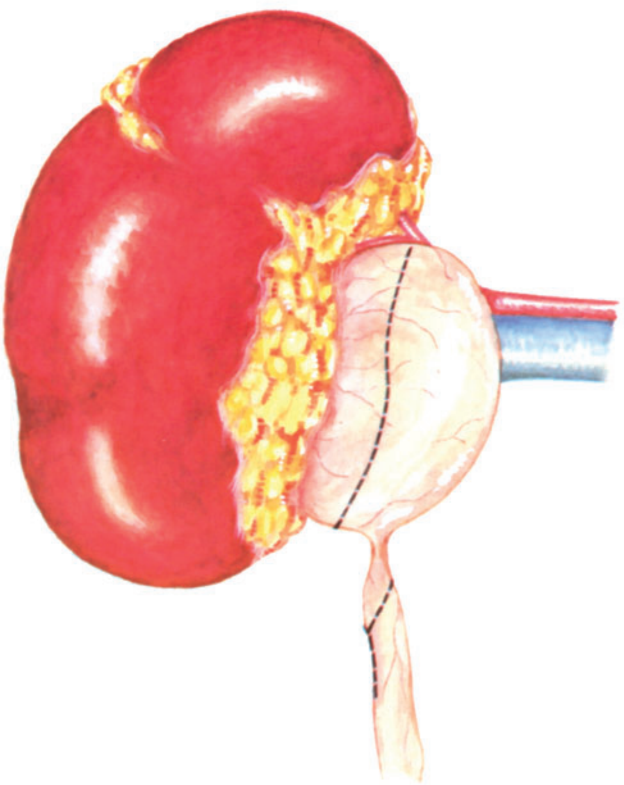
16. Hydronephrosis and Pyeloplasty

Either the lumbar flank or the transabdominal approach to the kidney can be used (see descriptions of these approaches earlier in this section on Operative Techniques). We do not prefer one approach over the other.

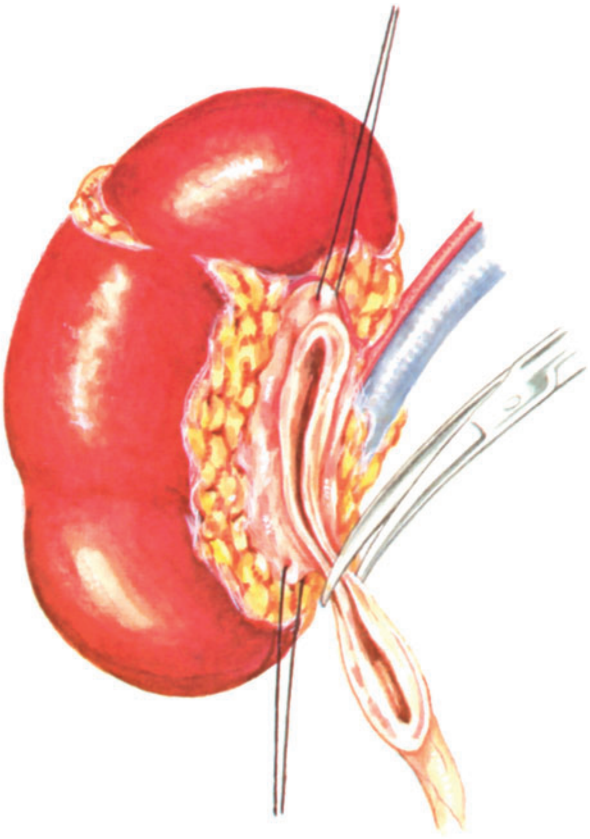
Diagnostic Work-up. Before a patient undergoes an operation for unilateral, congenital hydronephrosis, selected studies are helpful in addition to the intravenous pyelogram. We believe that a voiding cystourethrogram is indicated to rule out vesicoureteral reflux. Renal split-function tests, noninvasive, are useful. We use the photoscintiscanner with the Anger camera. After injection of 300 μCi (adult dose) hippuran ^{131}I, we can obtain renal plasma flow in each kidney. In many instances cystoscopy and retrograde pyelography may be required to demonstrate the ureteropelvic junction obstruction. We schedule this last procedure in the adult patient during late afternoon of the day prior to surgery.

16-1. In the *isolated posterior left kidney, the vein is anterior to the artery.* Both lines of incision are shown for a dismembered pyeloplasty.[1]

16-2. *Stay sutures guide the excision of excessive renal pelvis.*



16-1



16-2

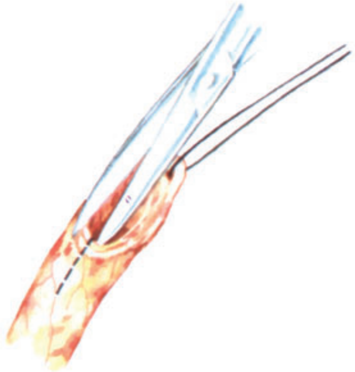
16-3. *The severed ureteral stoma is widened* by a longitudinal cut. One can avoid twisting the ureter by using a stay suture.

16-4. *One edge of the pyeloplasty has been accomplished by means of interrupted 4-0 chromic catgut sutures.*

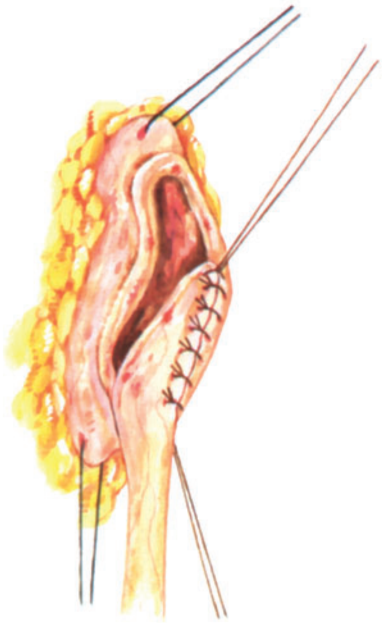
16-5. The pyeloplasty has been completed and *the remaining renal pelvis is reapproximated and sutured.*

16-6. *Pyeloplasty and pelvic closure are completed.*

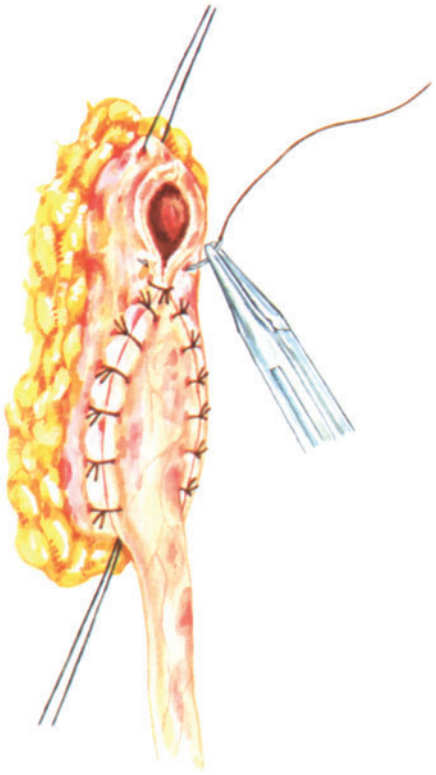
When the abdominal incision is closed, if the urine is uninfected, a nephrostomy tube is not used. A Penrose drain is placed near the pyeloplasty. A ureteral stent can be inserted, extending across the anastomotic junction and brought out as a nephrostomy. Extra holes in the stent, positioned at the renal pelvis, are helpful. Closure of the musculature and skin is performed in the usual fashion.



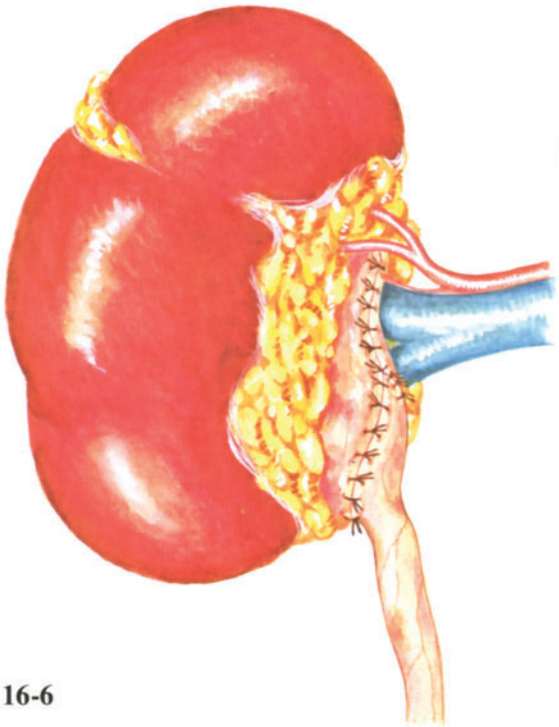
16-3



16-4



16-5



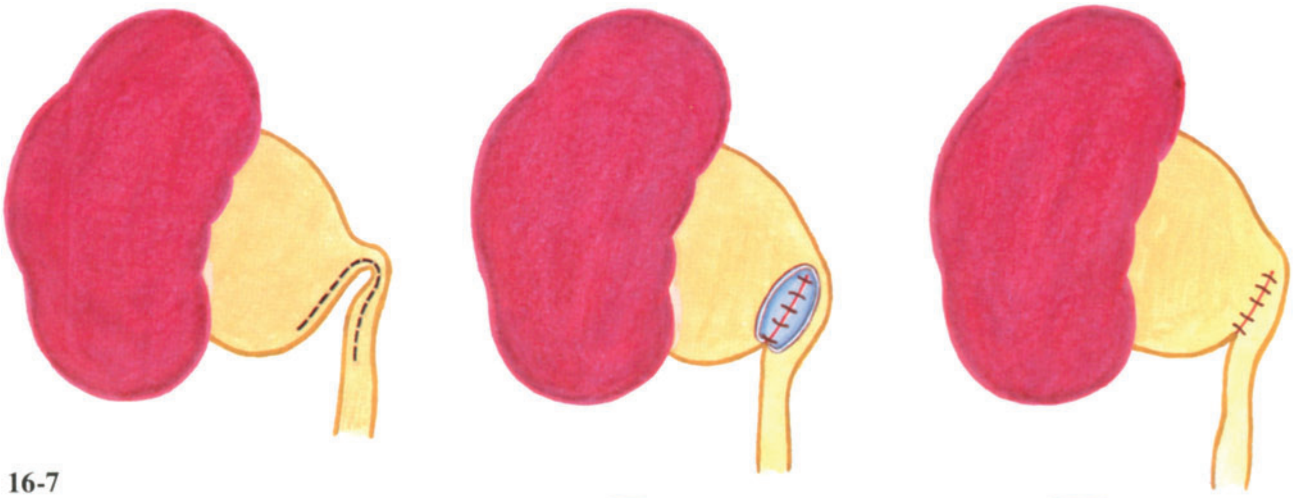
16-6

Variations of Technique for Hydronephrosis. The following illustrations schematize variations in surgical treatment.

16-7. *von Lichtenberg pyeloplasty* (Finney principle for pyloroplasty)[16]

16-8. *Foley-Y type pyeloplasty*[9]

16-9. *Culp–Scardino pyeloplasty*[6,15]



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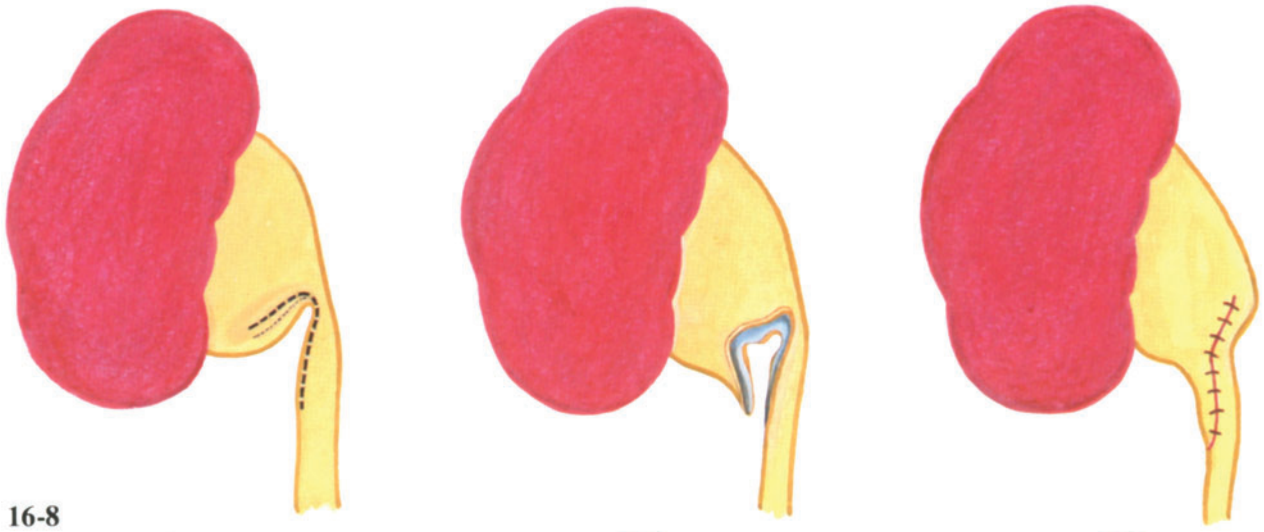

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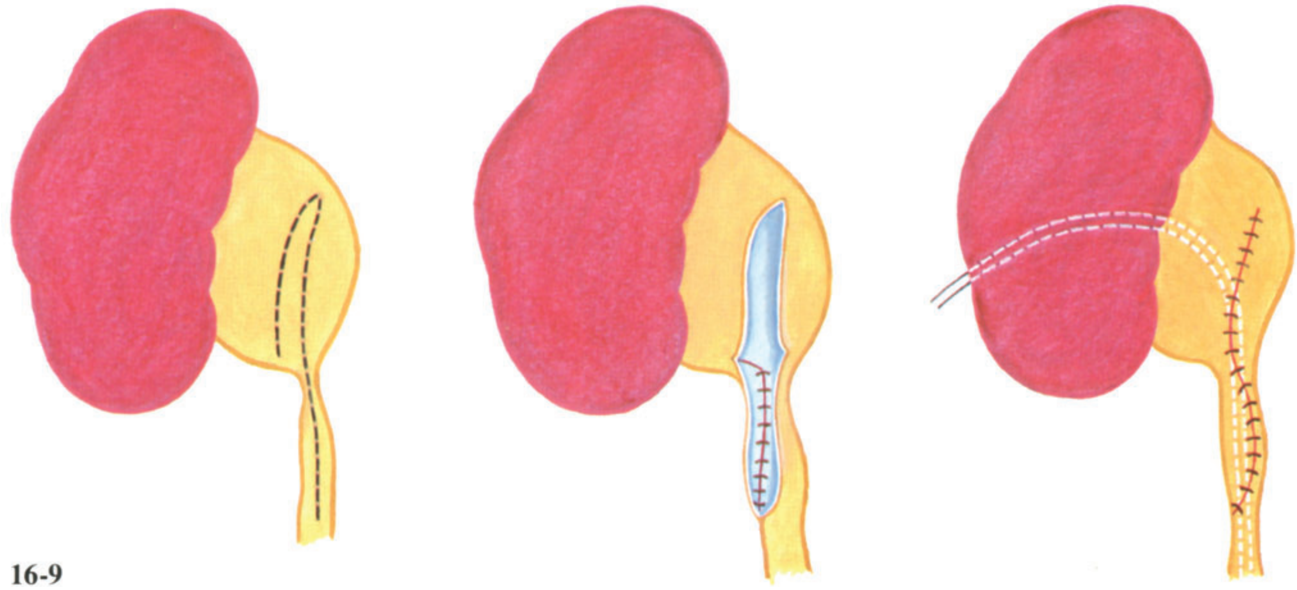

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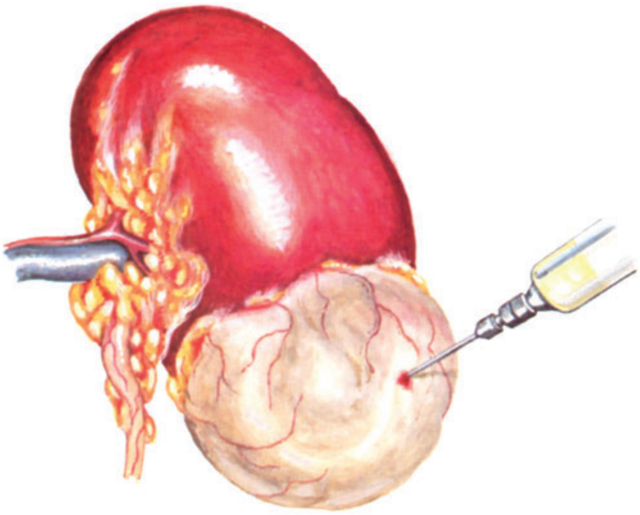
17. Surgical Treatment of Renal Cyst

The procedure is demonstrated on the left kidney lower pole. Either a flank or transabdominal incision can be used to reach the diseased organ. We prefer the flank approach.

17-1. *Fluid is aspirated* and submitted for cytology. If malignant cells are found, a nephrectomy is indicated at a later date.

17-2. The *cyst is circumferentially excised,* leaving a 1–2 mm cuff.

17-3. A *continuous hemostatic stitch* is used.



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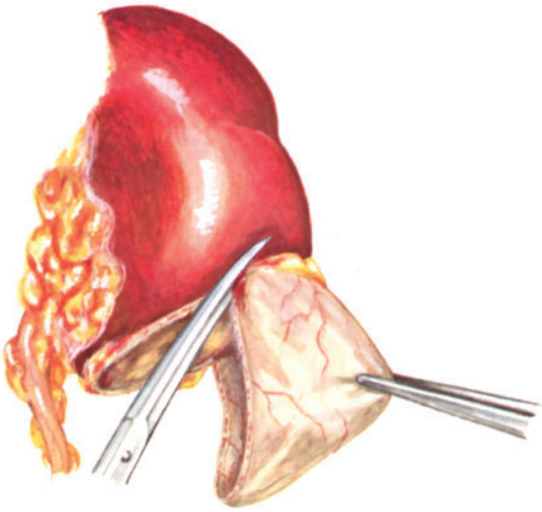

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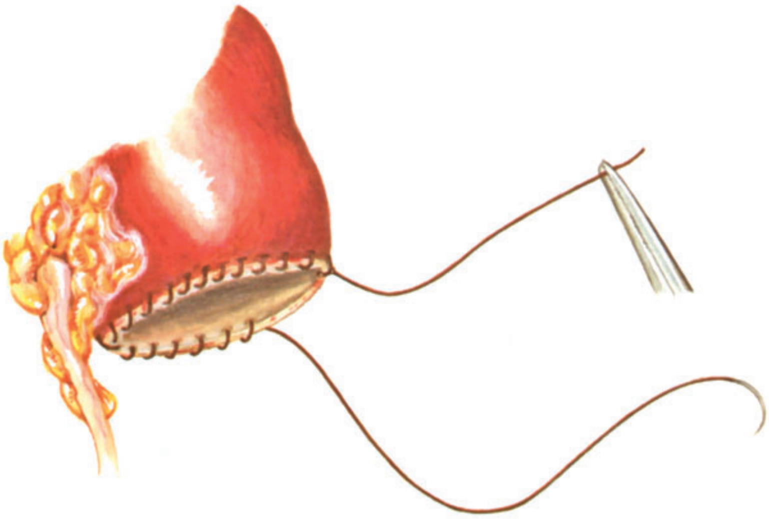

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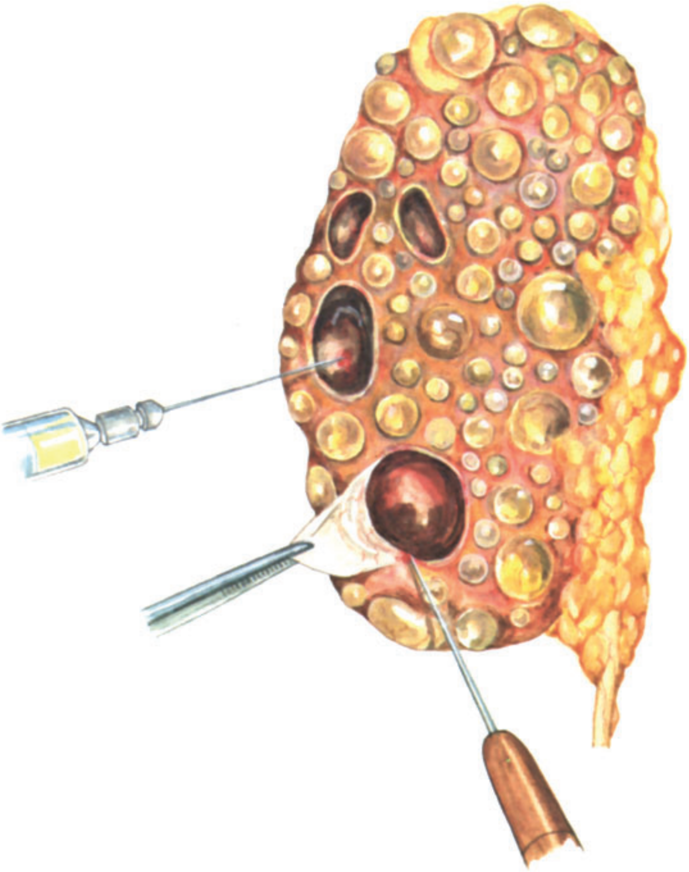


18-1

18. Surgical Treatment of Polycystic Kidney

18-1. Surgical treatment is indicated only in those patients with renal hypertension or evidence of progressive renal insufficiency. *The fluid is aspirated* and cultured. Antibiotic coverage is usually necessary and is begun preoperatively.

Kidney Transplantation

The operative approach for kidney transplantation will vary according to the patient—adult or child.

Indications for the procedure are determined by the presence of bilateral end-stage kidney disease necessitating chronic hemodialysis. Although it is unproved, we believe that tissue typing with matching of antigens between an unrelated donor and the recipient is important. Blood groups must be compatible and without evidence of elevated blood antibody titers in the recipient against the incoming donor lymphocytes (antigens). Recent reports suggest that multiple blood transfusions to the recipient prior to transplantation are beneficial.

For cadaver kidney transplantation, the organ must be carefully harvested and perfused under hypothermia for preservation.[11] We prefer en bloc dissection of both donor kidneys, including the adjacent aorta and vena cava. With donor kidneys meticulous care also must be taken to preserve the vascular supply to the ureters.

If a choice exists, a donor left kidney is reversed and implanted into the recipient's right iliac fossa. Hypothermic flushing of the donor kidney at the time of harvest, using an intracellular solution, can preserve function up to 18 hours.[12]

19. Adult

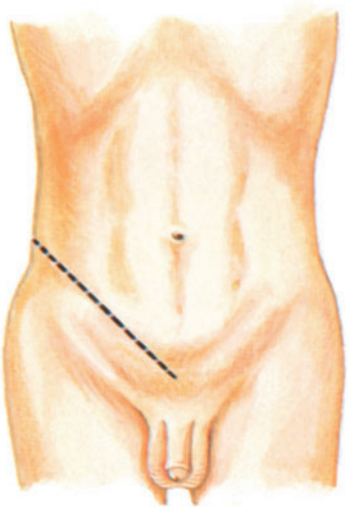
19-1. *The line of incision* for an adult patient is oblique and extraperitoneal.

19-2. The peritoneum is reflected medially. *The inferior epigastric artery and vein are individually ligated and divided.* In the male the vas deferens and spermatic chord on the side of the allograft are divided to prevent ureteral obstruction.

19-3. *The external iliac vein and internal iliac artery are exposed.* Care is taken to ligate all major lymphatic vessels to prevent fluid accumulation (the use of silver clips expedites this maneuver). Use of an umbilical tape around the hypogastric artery facilitates isolation of its major branches. At this point in the procedure the proximal hypogastric artery is freed and prepared for use. The distal branches are doubly ligated in continuity (2-0 silk) and transected between ties. A bulldog vascular clamp is placed at its origin. The external iliac vein is freed prior to the venotomy.

19-4. *Vascular clamps are placed on the external iliac vein superior and inferior to the venotomy site.* An elliptical venous window is created that approximates the size of the donor renal vein. The elliptical opening lies slightly anterolaterally. If a valve in the external iliac vein is noted, it must be made nonfunctional by sharp dissection.

The venous anastomosis is completed end-to-side prior to arterial anastomosis. Vascular sutures (5-0 nylon) are used in a continuous fashion from end to end. Heparinized saline is used several times to irrigate the lumens of both recipient and donor veins prior to closure.



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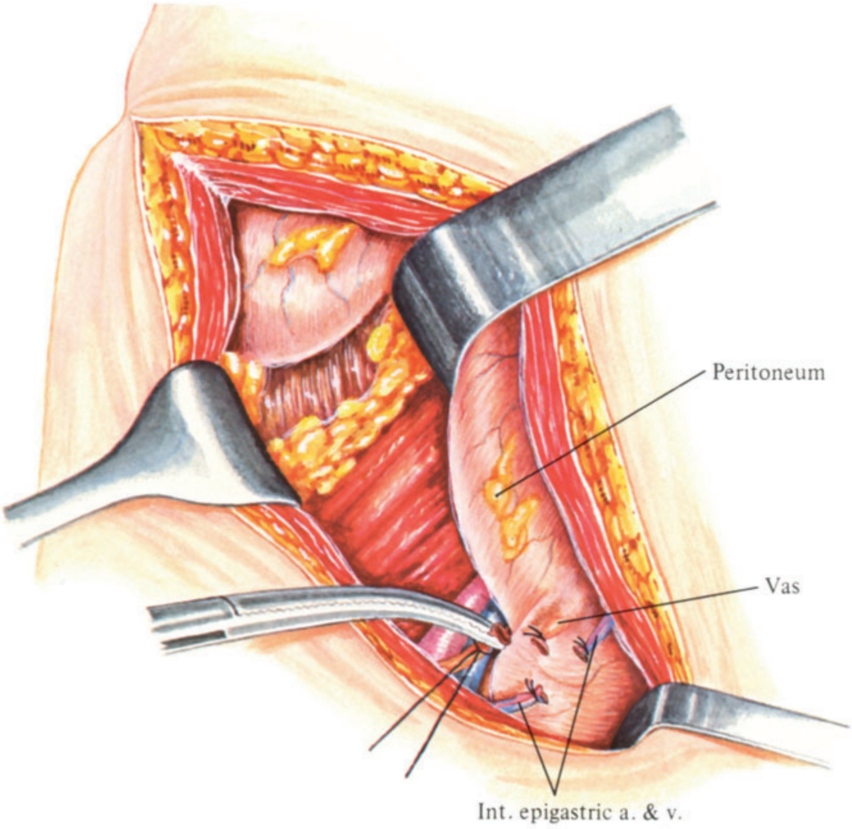

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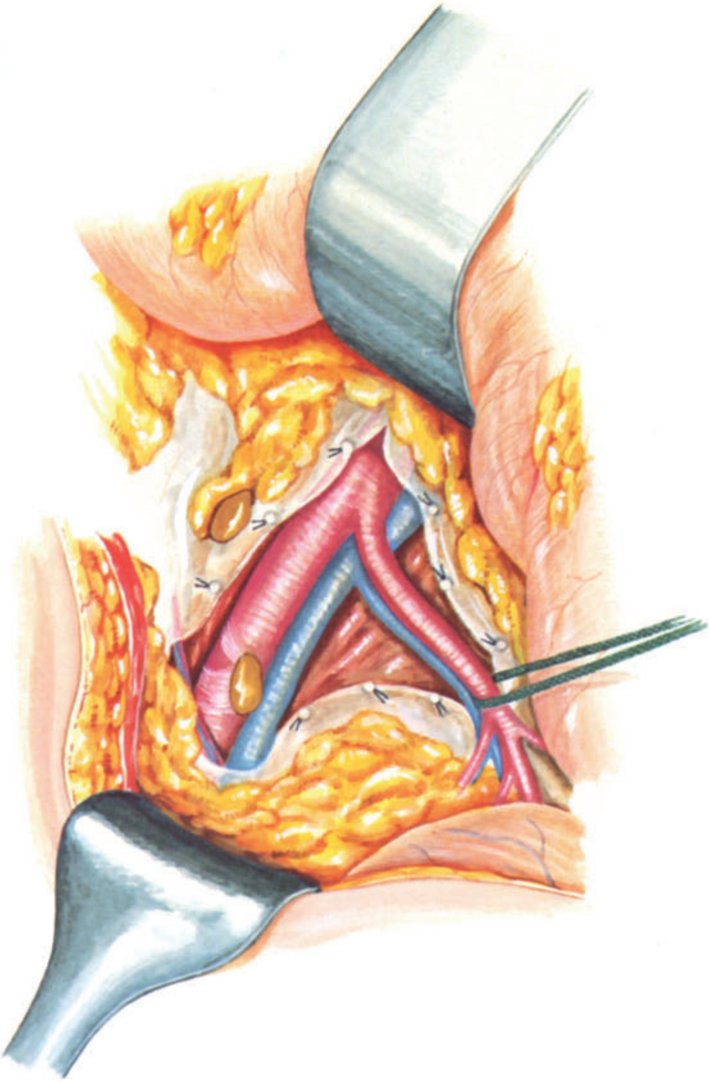

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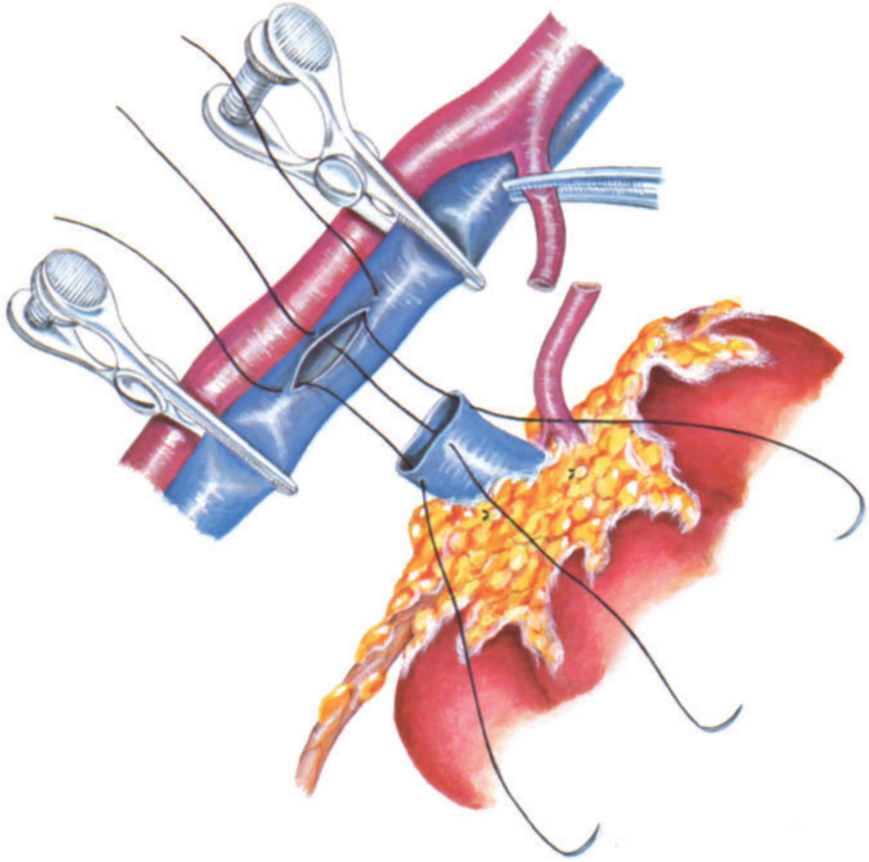

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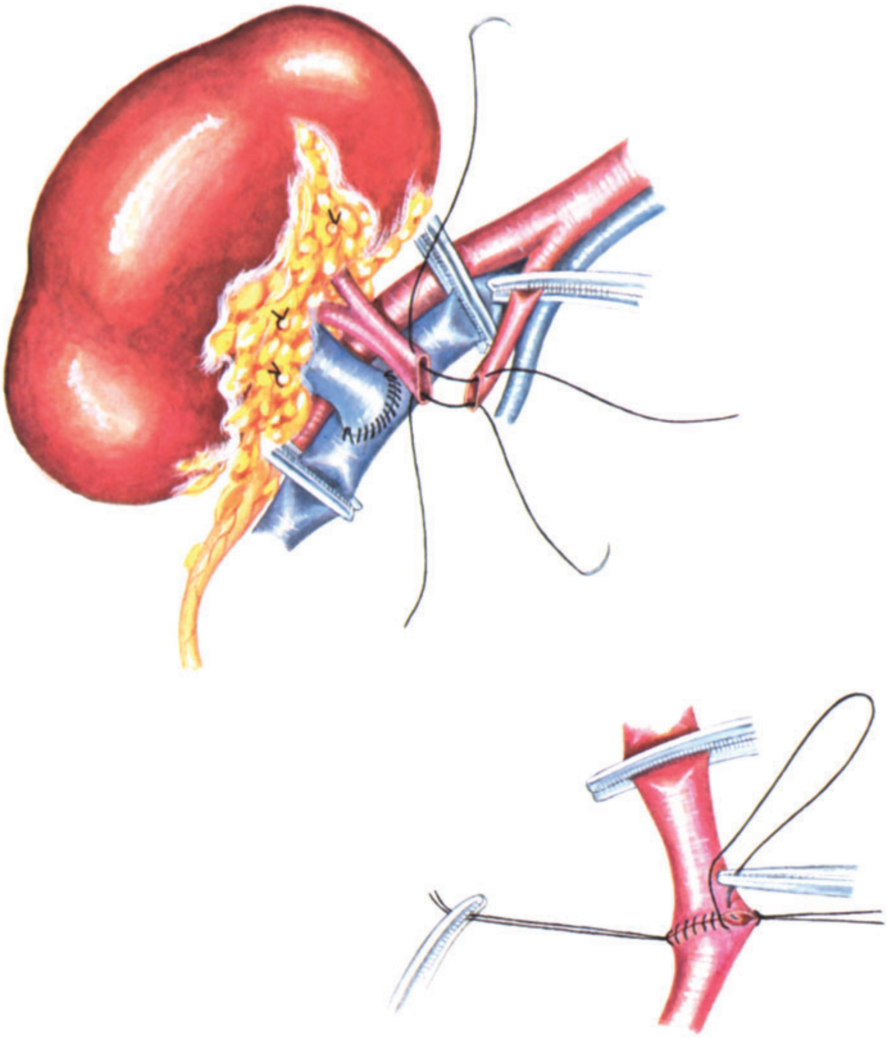
19-5. *Venous anastomosis and arterial end-to-end anastomosis (insert) are performed.* Heparinized saline is used to irrigate the arterial lumens prior to completion and suturing of the arterial ends. (During this interval the kidney is maintained at hypothermic levels—15° C—by cooling the capsular surface with refrigerated sterile saline.)

Vascular clamps are removed prior to proceeding with the ureteral neocystostomy. The superior venous clamp is removed before the inferior venous clamp. The arterial bulldog clamp is removed last.

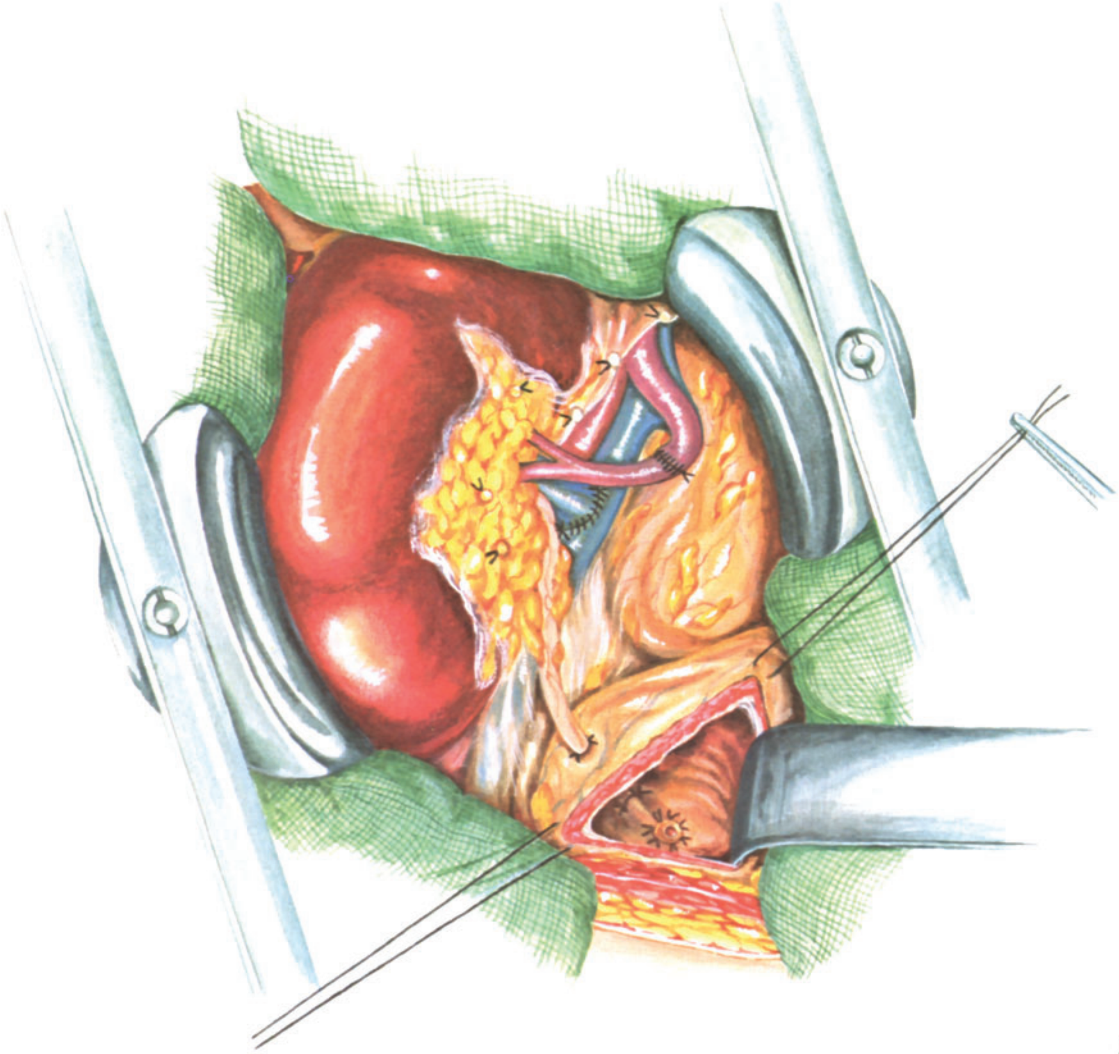
19-6. *Anastomosis of donor ureter into recipient bladder.* The Politano-Leadbetter technique is used.[13]

19-7. Briefly, *the ureter is inserted into the bladder* through a submucosal tunnel. Redundant ureter is excised. The ureteral stoma is secured to bladder mucosa by interrupted 4-0 chromic catgut sutures. The inferior sutures include bladder muscle and the mucosa at the inferior medial end of the



19-5

tunnel. Closure of the bladder wall is accomplished in two layers (3-0 chromic catgut). A watertight closure is important. A Penrose drain lateral to the bladder wall is inserted and maintained for 5–7 days. A Hemovac multiperforated tube may be substituted for the Penrose drain. A urethral indwelling Foley catheter (18 French) is introduced and maintained for 5 days.



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20. Child

It is usually difficult to transplant an adult donor kidney into a child. Therefore the incision is different from that used in an adult. A vertical or paramedian midline incision allows the cecum and ascending colon to be freed and retracted medially, exposing the great vessels.

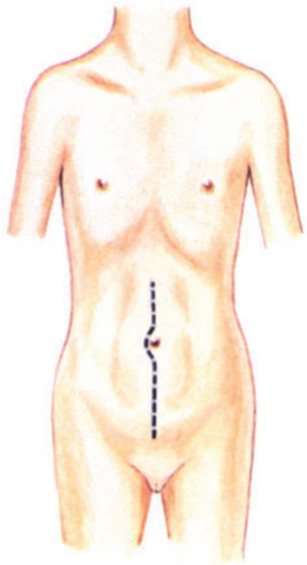
20-1. The appropriate *line of incision for a young recipient.*

20-2. Donor-recipient anastomosis varies from that normally used in an adult. *The donor renal artery is anastomosed to the abdominal aorta,* end to side. A Satinsky vascular clamp facilitates this anastomosis. The donor renal vein is anastomosed to the inferior vena cava, end to side. The ureter is implanted into the bladder by means of a submucosal tunnel.

21. Autotransplantation of the Kidney

The following illustrations schematically present a procedural technique to accomplish autotransplantation. A long vertical midline transabdominal incision is used. It extends from the mid-epigastrium to the symphysis pubis.

Case Report RB is a 15-year-old white female child who was observed to be hypertensive during a routine examination at high school in September 1976. A suspicion of renovascular hypertensive disease led to a complete work-up. The intravenous pyelogram revealed a delay in appearance time



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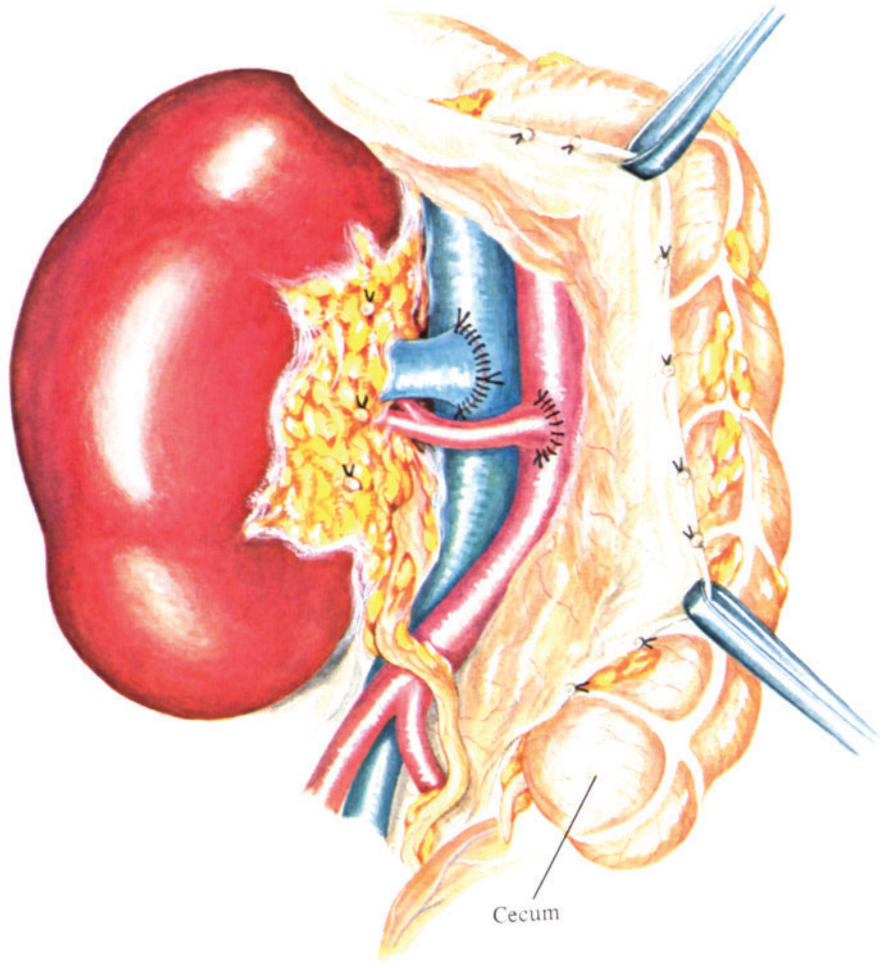

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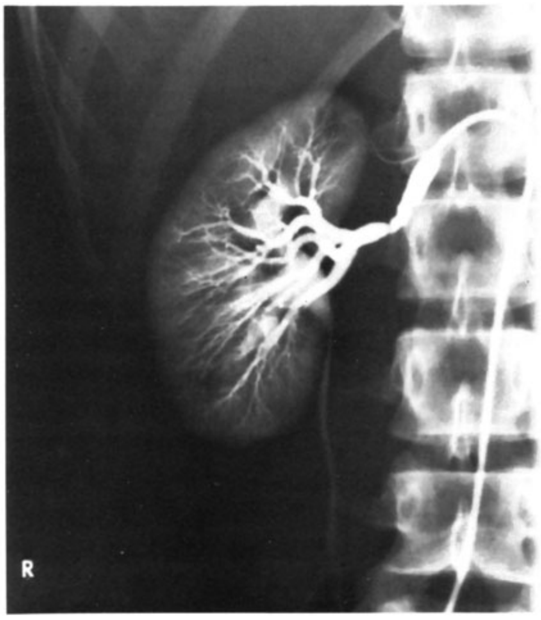


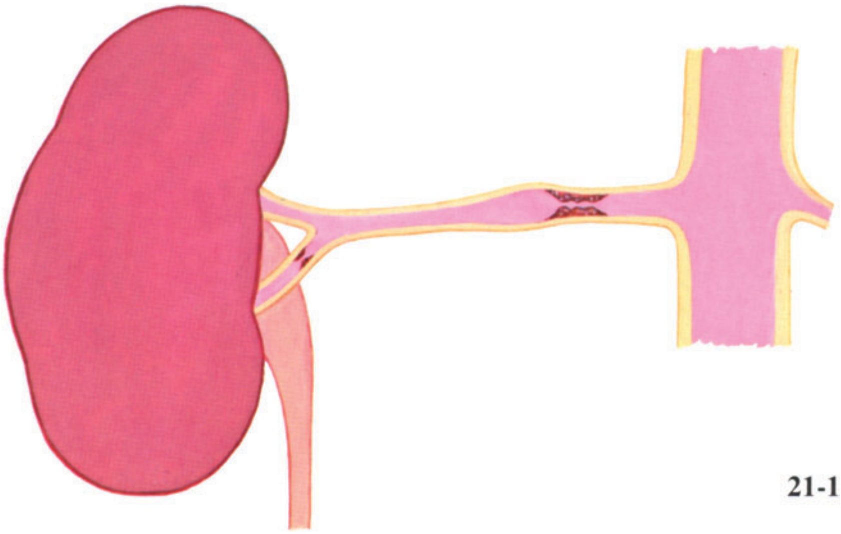
A

of contrast material in the right kidney. In the upright position nephroptosis of the right kidney was noted. Selective renal arteriography revealed 75% stenosis of the main right renal artery due to fibromuscular hyperplasia (Fig. A). In addition, secondary stenosis was seen in the primary arterial branch supplying the right lower pole. Renal vein blood samples were obtained for renin-angiotensin I assays. The right renal vein sample revealed a level of 38 ng/ml/hour (normal, 2.5 ng/ml/hour). The vein draining the right lower pole had an elevated level of renin-angiotensin I, 94.5 ng/ml/hour.

An autotransplant of the right kidney was performed in April 1977. Renal hypothermia was employed because of the known benefits of cooling.[4] The ureter was not transected. The lower pole renal arterial branch was dilated (coronary dilators) after the kidney was cooled outside the abdominal wall.

Her postoperative course in the past 20 months has revealed two normal peripheral vein renin levels. In addition, her blood pressure is 120/80 supine.

21-1. *Early fibromuscular hyperplasia in the proximal right renal artery* and its inferior branch.



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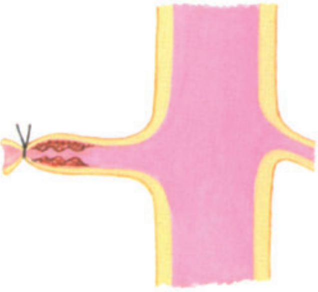
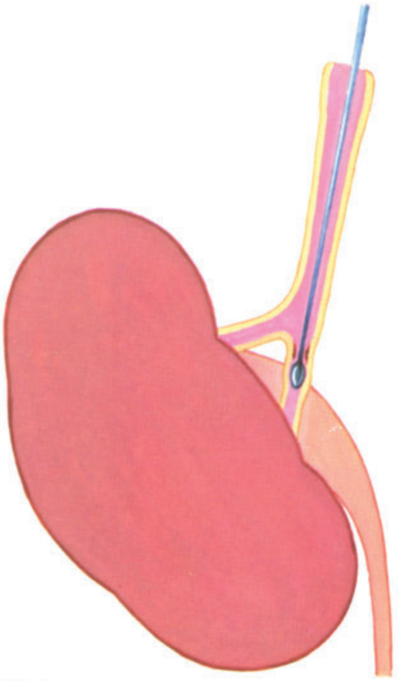
21-2. *The right renal artery and right renal vein (not shown) have been transected.* Care is taken so that the ureter remains in continuity, and its blood supply maintained. The kidney is removed from its bed and is cooled outside the incision line by the method described in the case report. The hypothermic kidney is conveniently positioned so that a coronary dilator (increasing sizes) can be inserted into the arterial lumen, in this case to reach the inferior branch of the renal artery, dilating the lesion.

21-3. After the stenosis is corrected, autotransplantation can be completed. *The kidney is rotated so that the poles are reversed.* The renal vein is anastomosed to the external iliac vein, end to side, and the renal artery is anastomosed to the hypogastric artery, end to end.

Renovascular Surgery[14]

Hypertension has recently attracted wide medical attention. Perhaps 28 million people in the United States have hypertension. The estimate is that in 3%–5% of those suffering hypertensive disease, the kidney is the source of the elevated blood pressure. A few centers specializing in renovascular surgery claim that the kidney can be implicated in 5%–15% of cases, but this figure is probably high and misleading.





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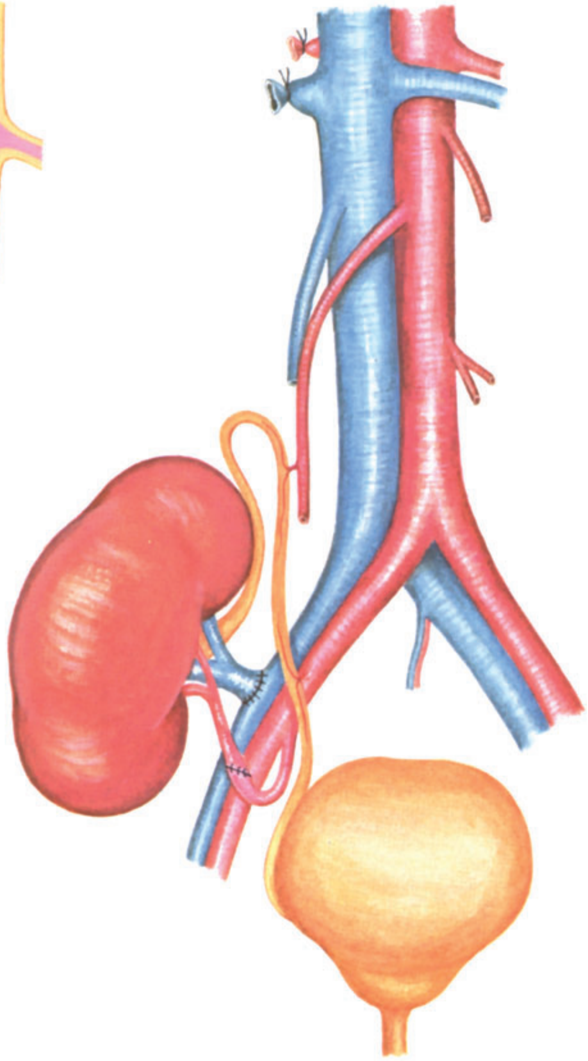

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Renovascular hypertension can be diagnosed in the main by noninvasive procedures today. A patient should undergo further investigation if there is a recent onset of hypertension in a young adult or worsening of hypertension in an adult (under 50 years of age). A negative family history in a patient with recent hypertension should spur the physician to obtain at least a rapid-sequence intravenous pyelogram and a renogram–renal scan–imaging study.

If patients previously responsive to medications for maintenance of normotension develop severe hypertension, then further diagnostic study is indicated to rule out renovascular ischemia.

A history of trauma to the flank or the occurrence of emboli to the lower extremities should alert the physician to the possibility of recent renal ischemia and hypertension.

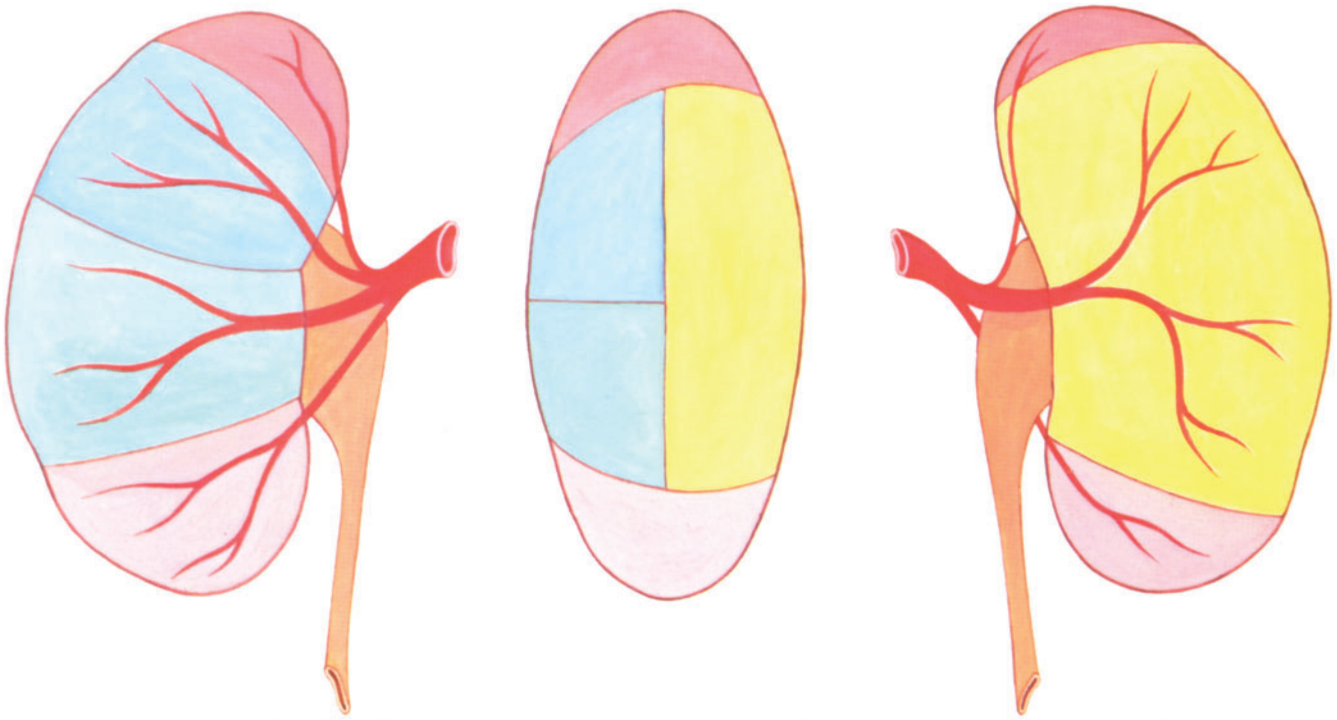
Diagnostic Work-up. The physical examination will document the presence of hypertension. In a child, the appropriate blood pressure reading is quite different from the adult normal pressure of 120/80 mm Hg. Similarly, a blood pressure of 135/90 may be normal in the patient in his fifth decade of life. An upper abdominal bruit is present in 80% of patients with severe renovascular disease. The murmur is heard just lateral to the midline of the epigastrium, particularly in fibromuscular disease.

Laboratory and X-ray Studies. The intravenous pyelogram, when performed in rapid sequence following the injection of contrast media, is still the most useful and practical test for identifying the affected kidney. Kidney size and disparity and abnormalities in configuration, can be noted. The early appearance of contrast media in each kidney is noted. Delay in appearance time is noted in renal ischemic kidneys.[5] Hyperconcentration of contrast media approximately 15–20 minutes following intravenous injection is also observed on the affected side.

We discontinue antihypertensive medications for 3 weeks in all patients undergoing a diagnostic work-up. We start these patients on a low-salt diet. On the day of study we ambulate the patient and keep the patient in the upright position for several hours before withdrawing peripheral venous blood for study of renin-angiotensin I levels. If the pressor levels determined by radioimmunoassay are elevated, then arteriography is performed, and renal vein blood samples are obtained for measurement of pressor substances.

We believe the use of the Anger camera attached as part of the photoscintiscanner apparatus is useful. We use a four-probe system that feeds data to a computer. Iodohippurate ^{131}I is injected intravenously after the kidney surfaces have been localized by using Technetium pertechnetate 99m. We have obtained renal plasma flow rates in each kidney by means of the four-probe system.

Renal arteriography is indicated to determine the severity and extent of renovascular disease. This study serves as a useful roadmap to the kidney proper. The two most common lesions demonstrated by arteriography are fibromuscular dysplasia and atherosclerotic plaques. The plaques occur in the more elderly patients and are located near the origin of the main renal arteries. The proximal one-third of both renal arteries or the aorta at its origin may be involved. Medial fibroplasia (fibromuscular dysplasia) is the most common type of mural dysplasia (75%) encountered. It often involves both arteries; if unilateral, it appears more often on the right side. The characteristic beading is seen in the female patient in the second, third, and fourth decades of life. The location of arterial dysplasia is in the distal two-thirds of the arterial tree and its primary branches.



a. Anterior view of right kidney **b.** View: opposite hilus **c.** Posterior view of right kidney

Contraindications to Surgery. Renovascular surgery may be contraindicated in an older patient with multiple system disease, including the cardiovascular system. If renal insufficiency is present, then surgery may be contraindicated. Finally, widespread and extensive renal arterial disease, if present, may preclude reconstructive surgery. Nephrectomy may also be contraindicated.

Anatomy of the Renal Artery and Its Major Intrarenal Branches. The renal arteries arise from the lateral aspect of the abdominal aorta opposite the superior border of the second lumbar vertebra. They course toward the renal hilus on each side. The right renal artery courses posterior to the inferior vena cava. Both renal veins lie anterior and slightly inferior to the renal artery. The left renal vein courses anterior to the aorta in the majority of cases.

In approximately 75% of cases each kidney is supplied by a single renal artery. Other variants are possible, including multiple renal arteries to each kidney. The single renal artery divides into an anterior and posterior branch near the midpoint of the aorta and renal hilus or in the hilar region.

The number of major branches coming off the renal artery varies from two to five. The schematic illustrates the usual trunks found on the anterior and posterior surface and the areas of kidney supplied by each major branch.

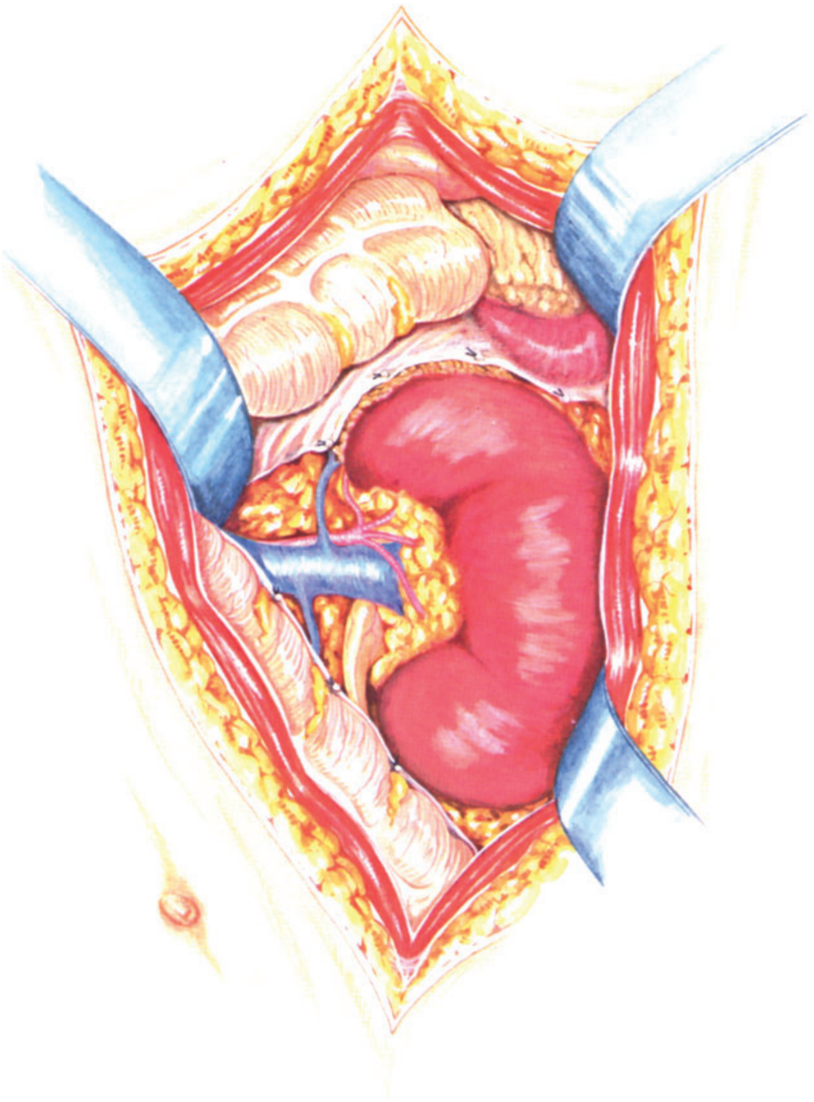
22. Transabdominal-Transperitoneal Approach to the Left Renal Artery and Left Kidney

The patient is in a supine position and the table is hyperextended so that the bend is at the second lumbar spine area. A sand bag or elevation of the kidney rest will assist in the hyperextension. An anterior vertical midline incision is made from the xiphoid process and curves around the umbilicus in an obese patient to the mid-lower abdomen. A transverse chevron-type incision, starting as a subcostal incision, is an excellent alternative.

The transverse colon can be lifted out of the wound onto the anterior superior abdominal wall and protected by a moist lap pad. The small bowel can be packed away into the right upper quadrant or placed into a plastic bag and lifted out of the wound onto the right lateral abdominal wall.

22-1. The approach to the left renal artery is effected by *mobilizing the splenic flexure of the colon and the descending colon.* The colon is freed by incising the paracolic peritoneal attachments. The lienocolic ligament must be severed before medial retraction of the upper descending colon is possible. After Gerota's fascia and the underlying kidney have been exposed, the renal hilar area is dissected by blunt and sharp dissection. The key anatomic landmark is the left renal vein coursing anterior to the aorta. Careful dissection of the renal vein will expose the adrenal vein and the spermatic vein. The renal artery is posterior to the vein and slightly superior. The major trunks of the left renal artery can be dissected near their origin.

22-2. *Elevation of the vein by a retractor.* The left renal artery is exposed.



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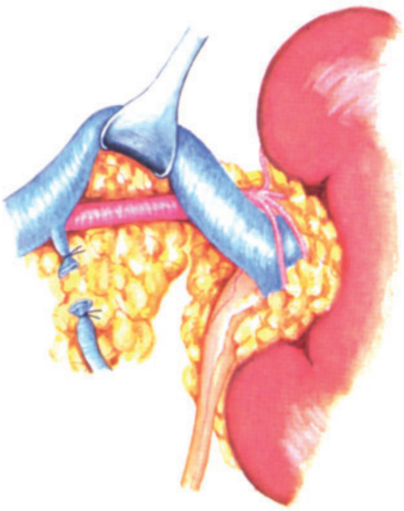

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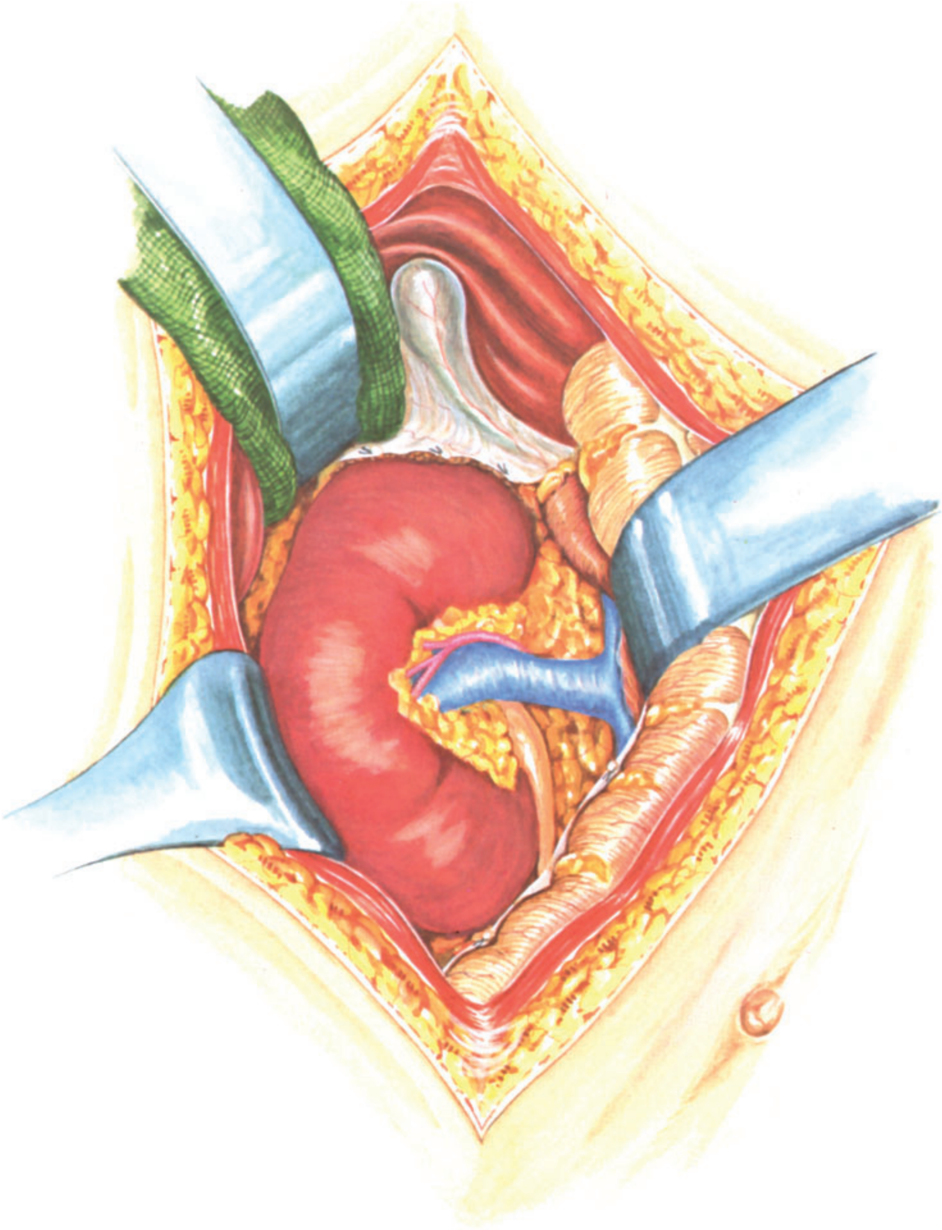
23. Transperitoneal Approach to the Right Renal Artery and Right Kidney

The incision and operative approach into the peritoneal cavity are as described for the left kidney. The ascending colon is mobilized by incising the paracolic reflection. The hepatocolic ligament is cut to free the hepatic flexure. The hepatic flexure and ascending colon can be retracted medially.

23-1. The *right renal vein is exposed* after Gerota's fascia has been opened and the renal hilus has been carefully exposed by dissection. The vein and ureter are exposed. The duodenum still overlies most of the inferior vena cava.

23-2. *Elevation of the renal vein and final exposure of the distal right renal artery* and its major extrarenal branches.



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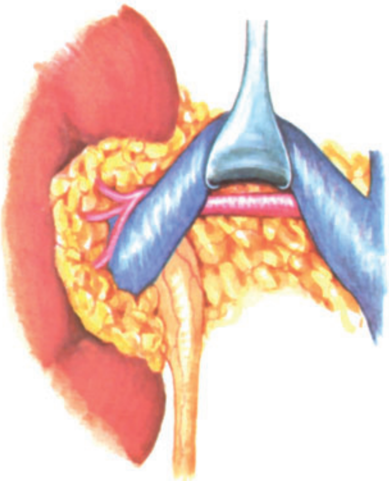

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24. Exposure of Both Renal Arteries

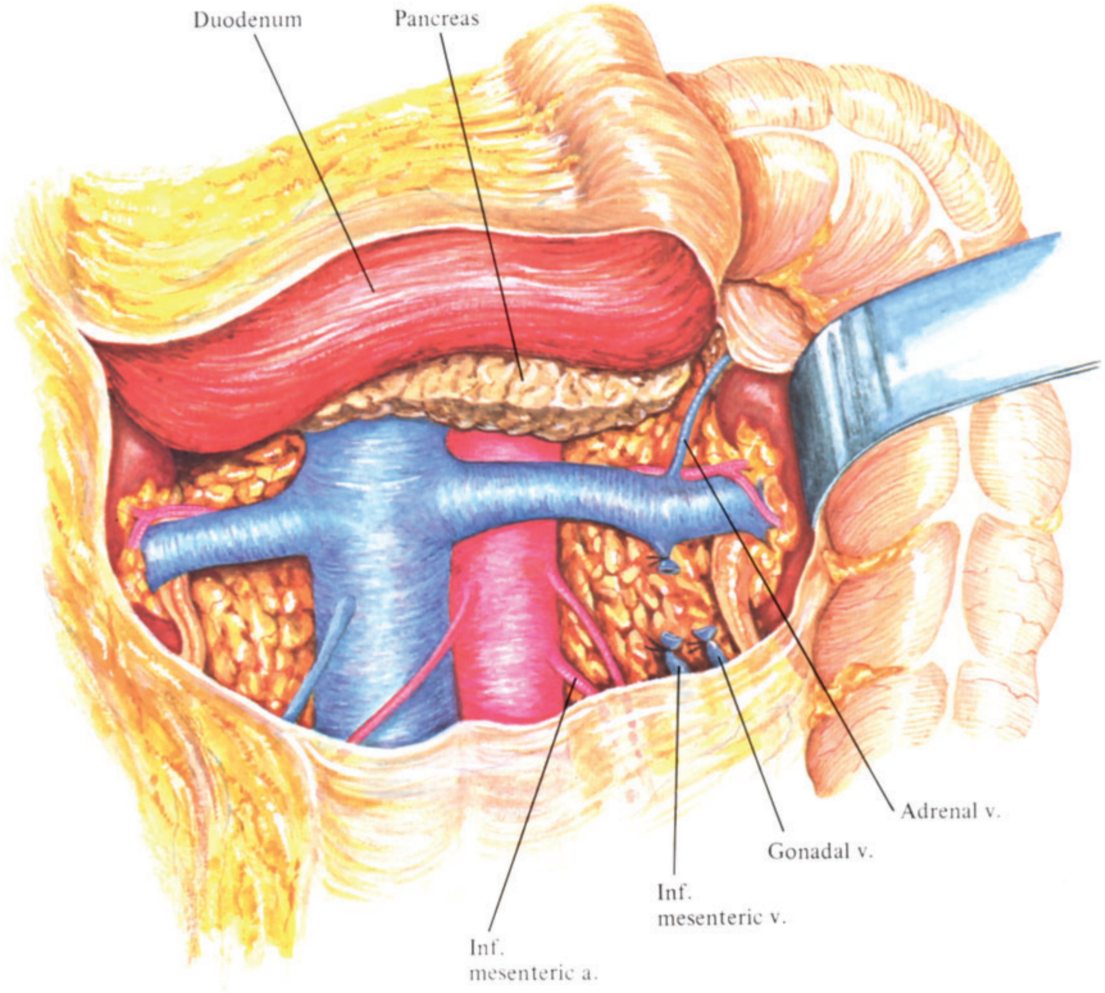
For a more direct approach to the proximal renal arteries, vena cava, and aorta, the duodenum must be mobilized and retracted medially and superiorly.

After the peritoneal cavity has been entered, the transverse colon is lifted out of the wound onto the superior portion of the incision. The small bowel is carefully placed into a plastic bag and lifted out of the right margin of the wound. The posterior parietal peritoneum is incised under the duodenum.

24-1. *Duodenal mobilization* is begun by incising or kocherizing the inferior and lateral border of the duodenum. The ascending portion of duodenum must also be freed before the duodenum can be rotated and lifted upward. The retroperitoneum can now be widened, and the major renal vessels can be dissected. The inferior mesenteric vein may be sacrificed to allow wider exposure. On the left side the spermatic vein may be doubly ligated and transected.

Once the inferior vena cava and renal veins are exposed, the underlying renal arteries can be easily reached and visualized.

The inferior vena cava is mobilized by blunt dissection. Even when the right renal artery is exposed at its origin, the left renal vein must be exposed and freed to allow lateral retraction of the vena cava. A large,



24-1

blunt, right-angle clamp or vascular clamp can be passed behind the vena cava. Umbilical tapes are then passed above and below the renal veins to allow control and mobilization. Ligating the spermatic vein on one or both sides assists in the exposure. Lumbar veins may be encountered behind the vena cava, and they can be controlled by a silver clip distally and a ligature proximally. The proximal third of the right renal artery can be exposed by retracting the vena cava laterally. For lesions of the distal two-thirds the vena cava is retracted medially and the right renal vein is raised superiorly or inferiorly as indicated. If the renal artery is clamped for more than 20 minutes, regional hypothermia may be indicated (see Figs. 8-2 and 8-3).

When one is operating on the proximal one-third of the renal arteries, the abdominal aorta should be mobilized. Abdominal tapes are passed behind the aorta superior and inferior to the renal arteries. This maneuver provides control of the major vessel should the vascular clamps slip from the proximal artery or part of the aorta.

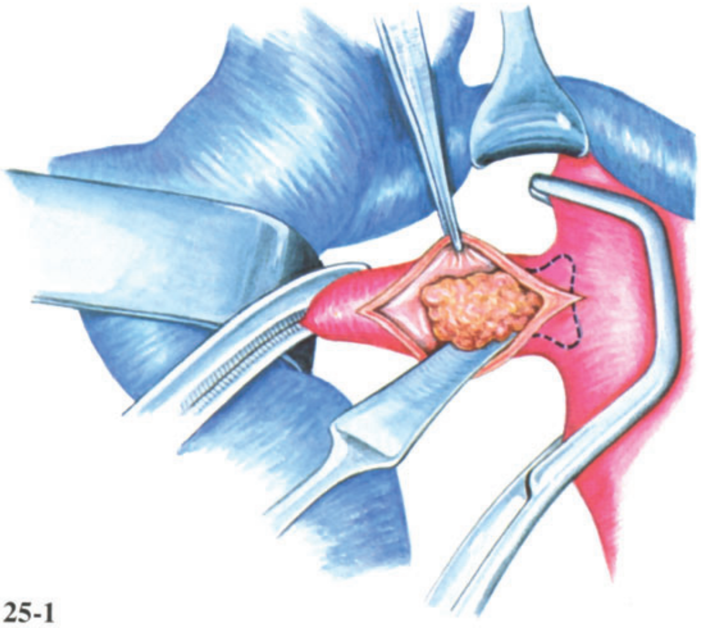
Heparin is usually administered before the renal artery or the aorta is clamped. Mannitol, 10% in Ringer's lactate, can be given 15 minutes prior to renal artery ischemia. It is continued during surgery and after the operation if renal hypothermia has not been employed. Approximately 1 liter can be administered over a 6-hour period with relative safety.

25. Endarterectomy of the Right Proximal Renal Artery

Endarterectomy of the right proximal renal artery may be performed when a plaque obstructing the renal vessel is found.

25-1. The *left renal vein is retracted superiorly,* and the vena cava is retracted laterally. An occlusive clamp is placed around part of the aorta to include the origin of the renal artery, but the aorta is not occluded completely. The distal renal artery is also clamped. An arteriotomy is made and can be extended into the aorta. A Cannon arterial dissector is used to dissect the plaque in a meticulous but complete fashion.

25-2. The *open renal artery may be closed* by a 5-0 continuous polypropylene or vascular nylon suture.



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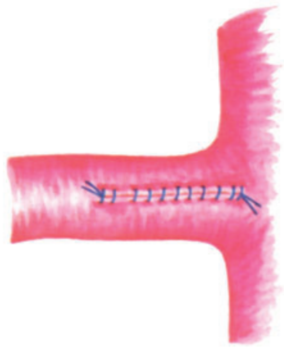

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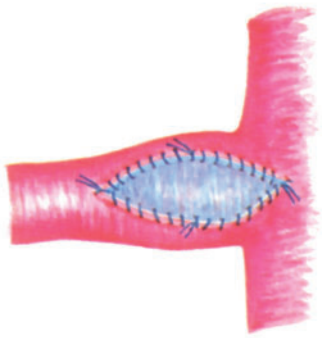


25-3

25-3. *A vein patch from the saphenous vein may be sutured in place to cover the defect.*

26. Segmental Removal of a Stenosed or Fibromuscular Segment

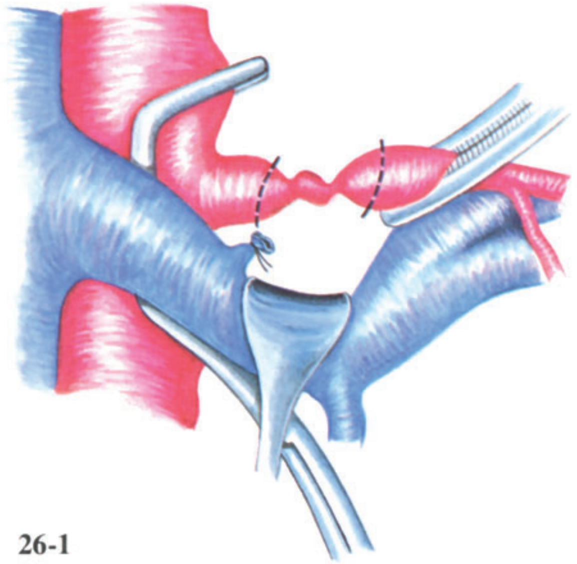
26-1. The left renal vein is retracted inferiorly. The adrenal vein and left spermatic vein are ligated. A vascular clamp is placed over part of the aorta, excluding the origin of the left renal artery. Flow through the aorta is not interrupted. A vascular clamp is placed on the distal renal artery, and the lesion (*dotted lines*) may then be removed.

Reanastomosis of the renal artery is performed by one of three acceptable techniques.

26-2. *End-to-end anastomosis*

26-3. *Interposition of a dacron tubular graft to reestablish flow*

26-4. *Saphenous vein graft to complete continuity.*



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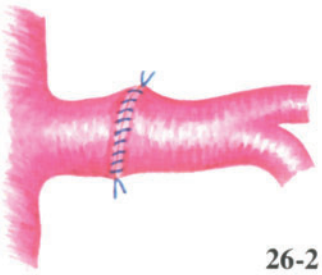

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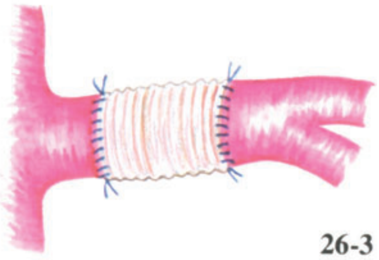

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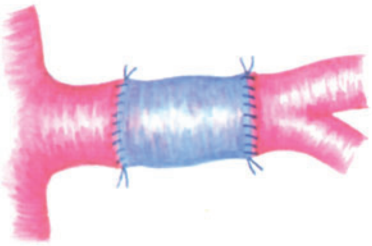


26-4

27. Aortorenal Dacron Bypass Graft from Mid-right Renal Artery to More Inferior Abdominal Aorta

27-1. The stenotic diseased proximal artery is seen on the right. *A dacron graft (end to side) is interposed.* The anastomosis of the artery to the graft is performed initially. Before the final sutures are placed, heparinized saline is used to fill the graft. Blood flow can also be initiated to seal the interstices of the graft.

27-2. *After the proximal renal artery has been freed of any diseased segment, it is reanastomosed to the aorta.* The vena cava is retracted laterally by a small Penrose drain used as a tape to allow adequate exposure. The aorta is temporarily occluded to permit the anastomosis (end to side) in a bloodless field. Heparinization of the patient is important. Renal hypothermia can be used to protect kidney function.

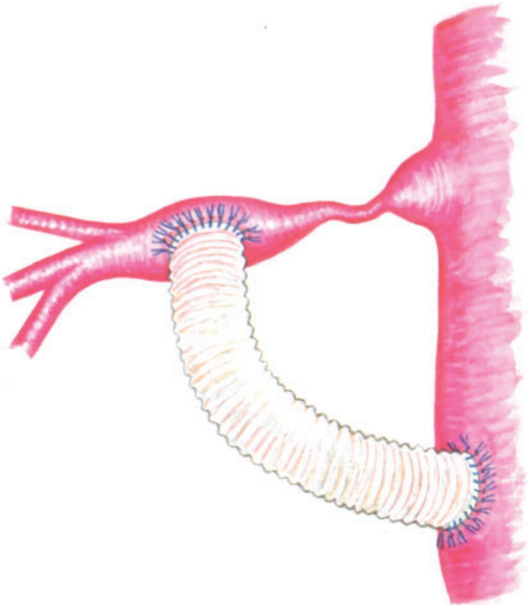
28. Splenorenal Arterial Anastomosis

Before formal plans are made to use the splenic artery, it is important that the splenic branch of the celiac axis be visualized. Atherosclerosis in the vessel will preclude its use. Oblique arteriograms of the splenic artery are useful.

The splenorenal bypass procedure is more difficult than other renovascular procedures. This is particularly pertinent if one uses the surgical approach consisting of an anterior duodenal mobilization.

We prefer a slight flank abdominal approach through the bed of the 11th rib. We usually can avoid entrance into the pleural cavity. If the pleura is entered, then a tube is used to empty the pleural cavity of air prior to closure.

Using the approach posterior to the left kidney and flank area, we can dissect the renal artery from its mid renal portion. By entering the peritoneal cavity it is now possible to identify the splenic artery and vein.



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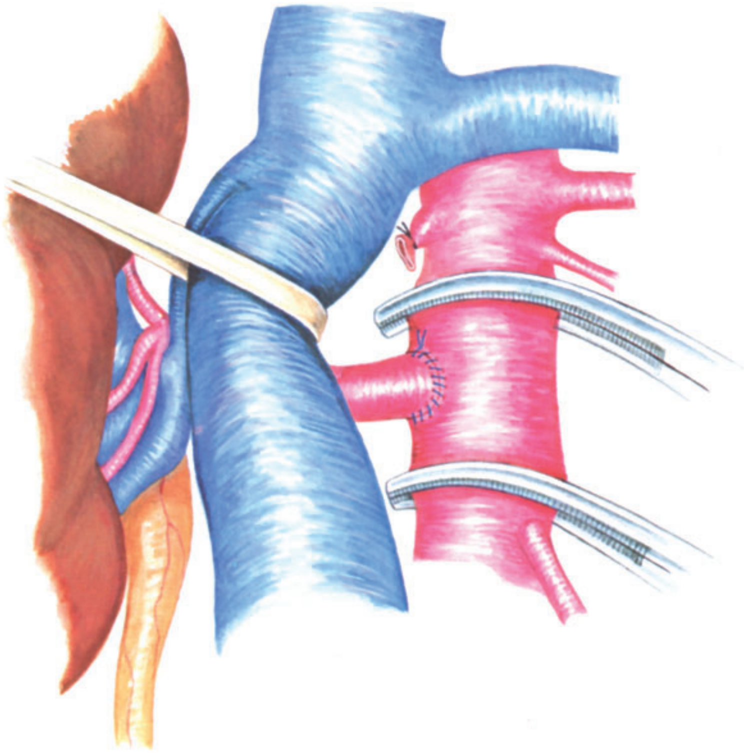


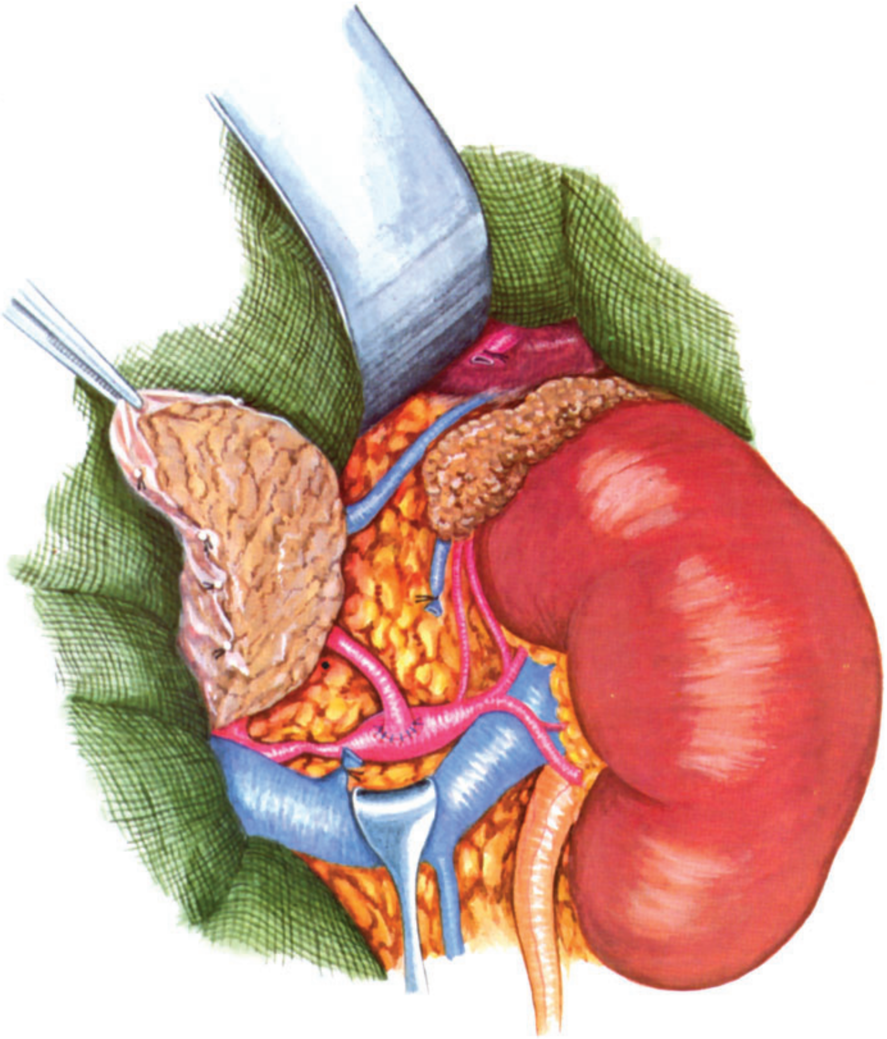
27-2

An excellent guide to the splenic vein is the inferior mesenteric vein near its entrance into the vena cava. The splenic artery can be isolated adjacent to the vein. The artery is isolated by a tape and carefully dissected to prevent injury to the pancreas. Sufficient mobilization must be carried out so that the artery can reach the renal artery without tension.

Arterial branches supplying the pancreas and adjacent viscera must be ligated. The adrenal vein to the left renal vein is also doubly ligated. Now the proximal splenic artery is occluded with a vascular clamp. It is not necessary to remove the spleen because of excellent collaterals from the short gastric arteries.

Most vascular surgeons prefer an end-to-side anastomosis. The renal artery is mobilized and heparin and intravenous mannitol (10%) are administered. The renal artery is occluded on both sides of the anastomosis. The divided splenic artery (distal side has been ligated) is brought to the site of anastomosis. An arteriotomy in the renal artery is made.

28-1. *The end of the splenic artery is approximated to the open renal artery by vascular sutures* (5-0) on each end. The splenic artery can be dilated or spatulated to accommodate the arteriotomy if necessary. The posterior row is sutured first. The anastomosis is then completed.



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29. Removal of Extrarenal Aneurysm, Right Renal Artery

The success of any procedure in urology depends on adequate exposure of the field. We believe that renal hypothermia to the parenchymal surface is useful in protecting kidney function during the period of renal ischemia.

The right renal artery is exposed (see Figs. 23-1 and 23-2). The inferior vena cava is retracted medially. The renal vein is retracted inferiorly.

29-1. *The aneurysm can be carefully exposed.* The renal arterial branch beyond the aneurysm must also be dissected.

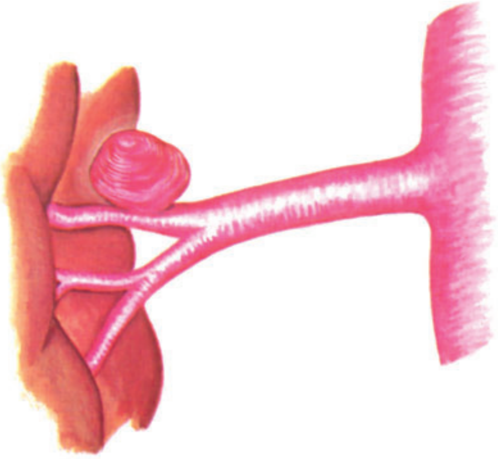
29-2. *An abdominal tape is placed under tension* (or a small bulldog clamp can be substituted) to prevent backflow. A vascular clamp is placed on proximal renal artery. The aneurysm is excised. The remaining vessel is examined.

29-3. *A saphenous vein patch* is freed and fashioned so that a patch graft can be completed as shown.

30. Renal Artery Aneurysm Involving Entire Right Renal Artery at Major Bifurcation into Posterior and Anterior Branches

A midline approach to the kidney, using a transperitoneal exposure, is satisfactory. The paracolic space on the right is exposed by retracting the ascending colon medially. The renal artery is exposed proximal and distal to the aneurysm. This exposure is enhanced by retracting the vena cava medially. Renal hypothermia (15° C) is useful and protects renal function during the period of renal ischemia. We use a surface cooler.

An alternative to the procedure we describe in situ is the use of "workbench" surgery. It is important that the ureter be protected. In this technique the kidney is removed from its bed after the proximal renal artery and renal vein are divided. The kidney is cooled by immersing the organ in cold saline slush. The aneurysm is excised, and the renal artery can be further cooled by cannulating both distal artery branches and infusing a hypothermic 7° C solution (250 ml) into each branch.



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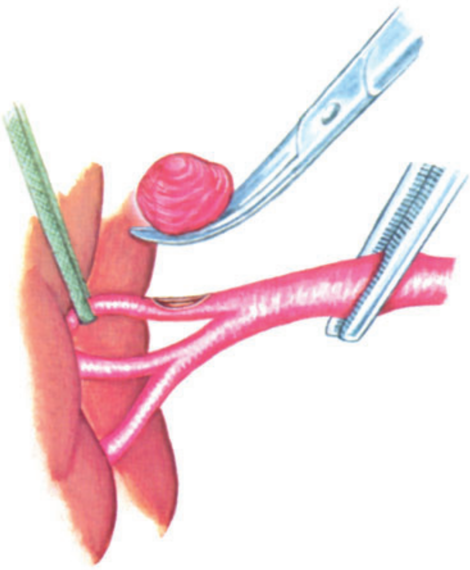

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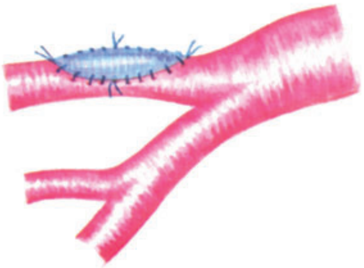

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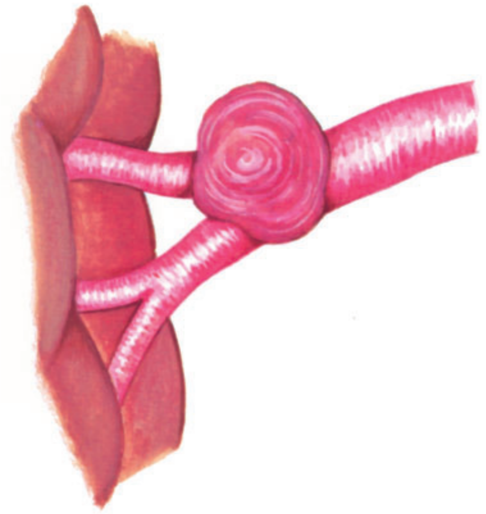

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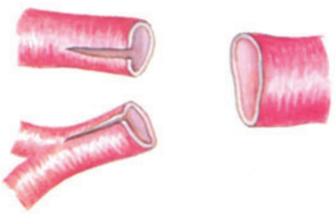

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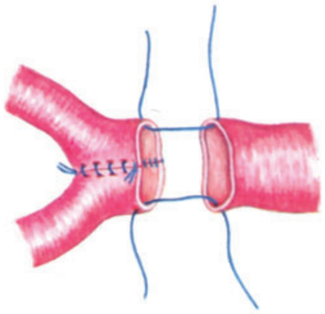

30-3

30-1. *The aneurysm is exposed* after the renal artery and its distal major branches are carefully dissected and exposed. A vascular clamp is placed proximally. Two small bulldog clamps are placed distally. The aneurysm is excised.

30-2. *Reestablishment of continuity is effected by incising both distal branches* in longitudinal fashion at a site where they would lie in apposition. The incision is about 8 mm in length. The side-to-side anastomosis distally is completed first, thus widening the stoma.

30-3. *End-to-end anastomosis* (5-0 nylon vascular suture) is completed.

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The Ureter

2

Surgical Anatomy

Structure and Location

The ureters are fibromuscular structures that transport urine from the kidney pelvis to the bladder; the ureters begin at ureteropelvic junction as a continuation of renal pelvis and extend to the ureteral orifices. Their lengths in the adult are 25–34 cm. The left ureter is about 1 cm longer than the right one. Both ureters are retroperitoneal in their course and attach loosely to the posterior layer of peritoneum with the exception of the upper 4–5 cm.

From the ureteropelvic junction to the iliac vessels, the ureters lie on the anterior surface of the left and right psoas major muscles (Fig. 1). The right ureter courses lateral to the inferior vena cava. The upper portion is covered by duodenum. The left ureter can be located lateral to the inferior mesenteric vein. The spermatic or ovarian vessels lie medial to the ureter for the superior half, then cross over to continue downward in a lateral location to ureter.

Surgical Recognition

The ureter is a fibromuscular structure that demonstrates peristaltic activity when compressed with atraumatic forceps. The best method to locate the mid-ureter is to find this structure as it crosses anterior to the common iliac artery at the origin of the hypogastric artery. The ureter can be palpated at this junction. The ureteral surface has an increased capillary and arteriolar network which will aid in recognition.

In gynecologic surgery the lower ureter may be traumatized. Ureteral catheterization facilitates identification of the ureter. A fiberoptic ureteroscope entails the use of a 7 or 8 French catheter. We do not use this instrument because of possible trauma to the ureteral wall.

The pelvic ureter crosses the common iliac vessels at its bifurcation, passes along the lower border of the internal iliac artery and crosses its anterior branches. As the ureter approaches the bladder, it is retroperitoneal. The lower ureter is surrounded by a plexus of veins; the terminal ureter passes obliquely through the bladder wall for about 2 cm (Fig. 2).

In the female, the terminal ureter passes the supravaginal part of the cervix, about 1.5–2.5 cm in a lateral position, and is covered by the uterine artery and veins; it enters the posterior vesical wall obliquely (Fig. 3).

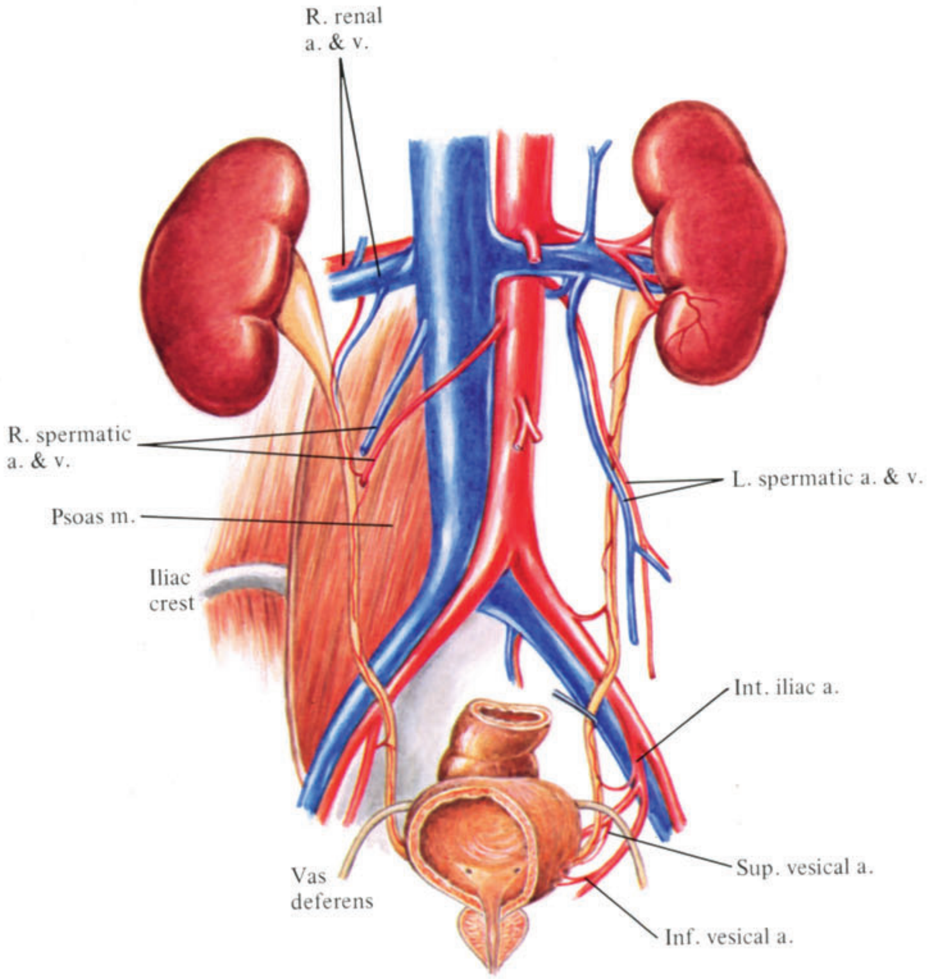


FIG. 1. The ureters and vascular supply in the male.

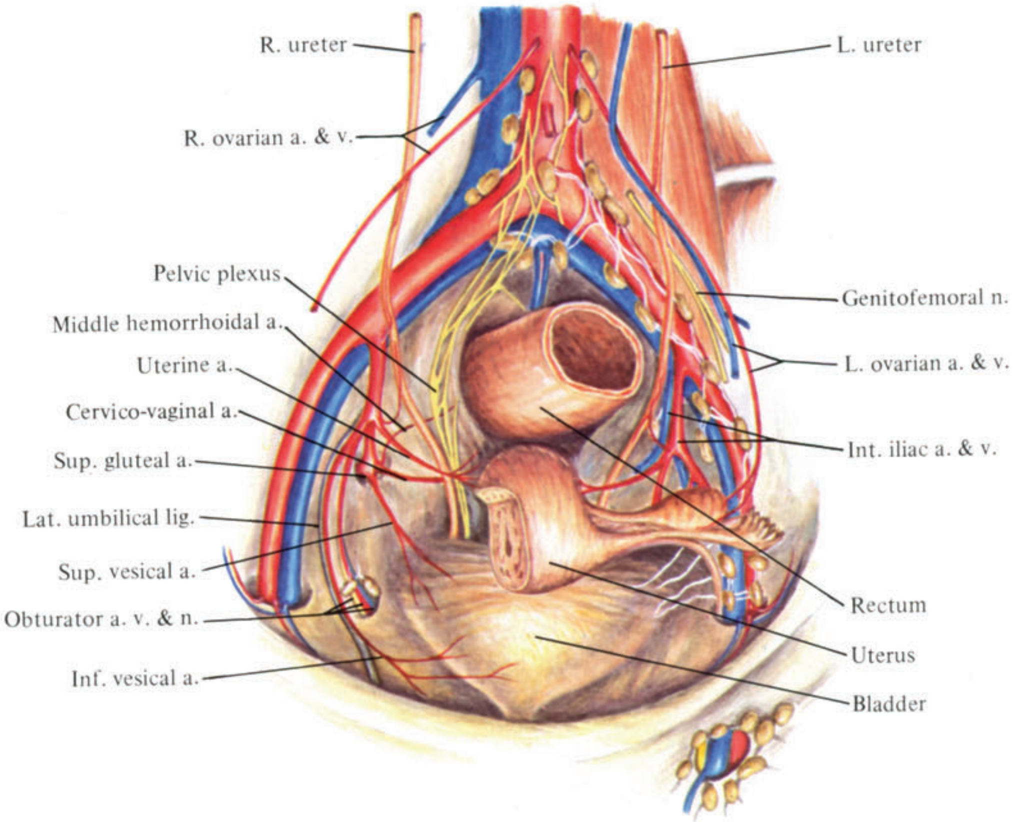


FIG. 2. Pelvic portion of ureter in the female.

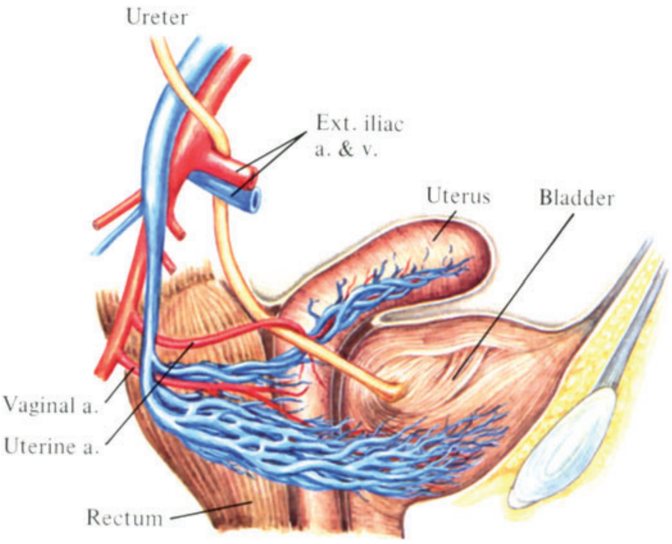


FIG. 3. Deep pelvic part of ureter in the female, lateral view.

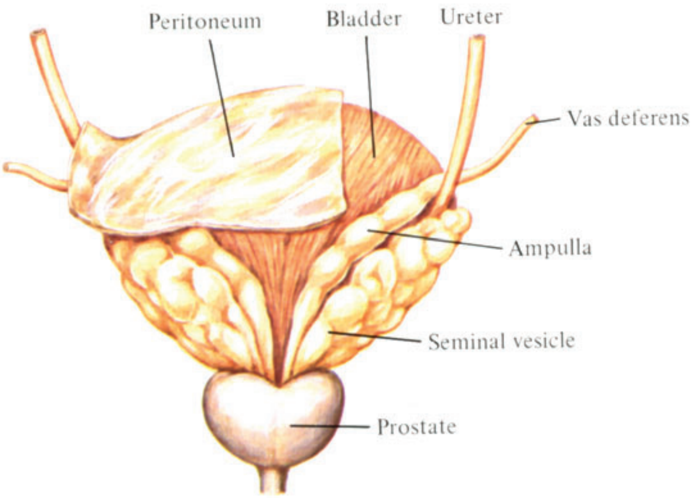


FIG. 4. Posterior view of the prostate, seminal vesicles, and vas deferens.

In the male, the terminal ureter is crossed by the vas deferens above the ureterovesical junction and is nearly overlapped by the upper end of the seminal vesicle. (Fig. 4).

Three narrow areas are recognized along the course of each ureter: The uppermost is at the ureteropelvic junction. The second occurs where the ureter crosses the iliac vessels at the pelvic brim. The third is within the bladder wall (ureterovesical junction). These narrow areas often impede passage of urinary calculi. The intravesical portion of the ureter is the narrowest; it has only a longitudinal muscle layer and is an important topographic point with regard to ureteral reflux.

Vascular Supply

The arterial supply to the ureters is derived from several sources. The extrarenal pelvis and upper ureter are supplied by branches from the renal artery. The middle third of the ureter derives its supply from branches of the gonadal, the colic, and the common iliac or hypogastric arteries. The lower third of the ureter is supplied by arteries arising from the superior vesical, middle hemorrhoidal, and inferior vesical arteries (Figs. 1 and 2).

These vessels from several sources anastomose freely, forming a fine network covering the ureter. Because of this vascular network, the ureter can withstand a considerable amount of surgical trauma without fear of sloughing.

The veins begin as a fine meshwork and empty into the main veins, which correspond largely to the adjacent arteries.

Lymphatics communicate with the lymph nodes nearest the ureter in the abdomen and pelvis.

Nerve Supply

Nerves supplying the upper ureter are mostly from the plexus accompanying the ovarian or spermatic artery. The lower ureter derives its supply from the hypogastric and pelvic plexus. The nerves are derived mostly from sympathetic trunks and are independent of the renal pelvis and bladder (Fig. 5).

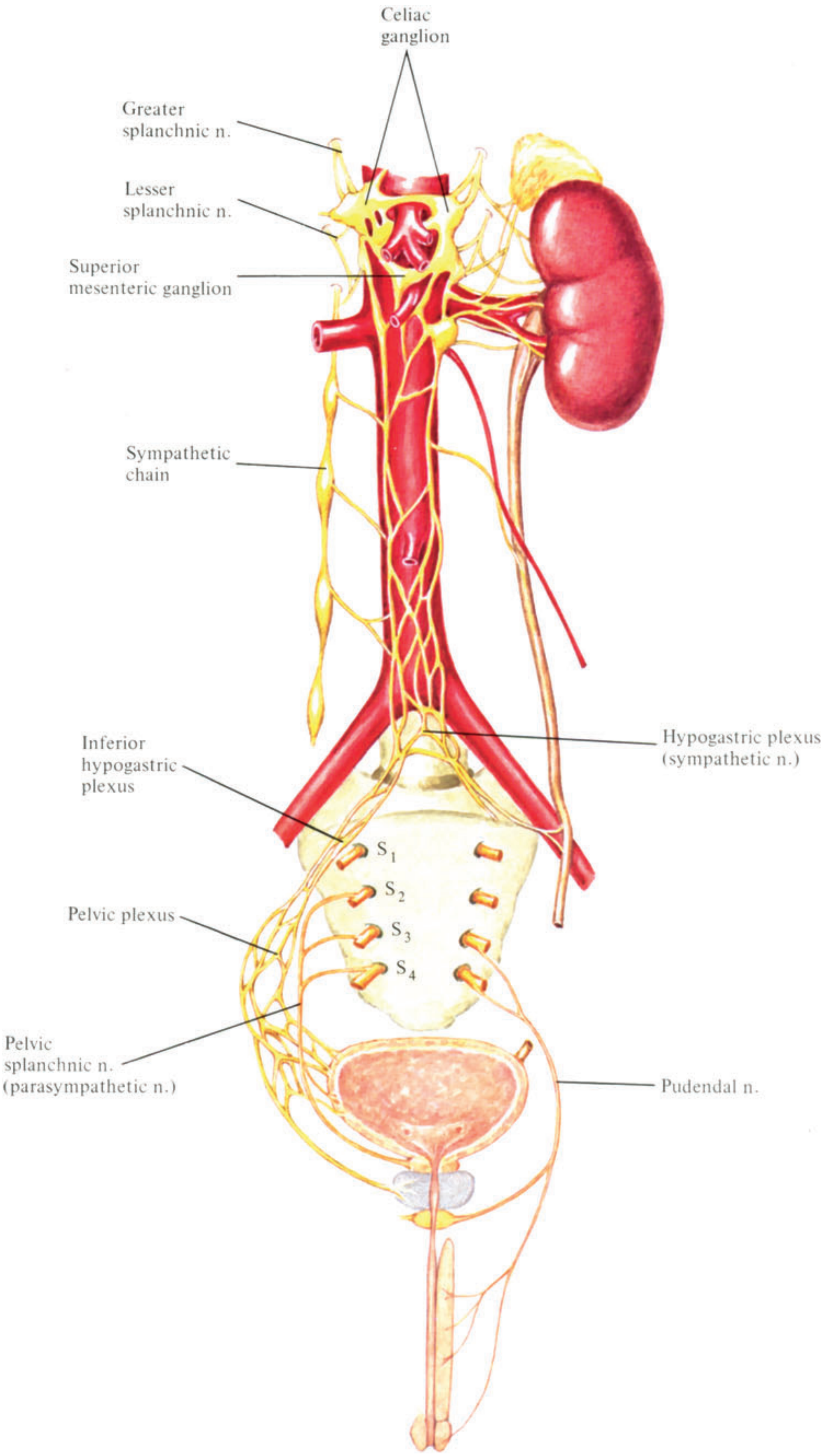

Celiac ganglion
Greater splanchnic n.
Lesser splanchnic n.
Superior mesenteric ganglion
Sympathetic chain
Inferior hypogastric plexus
Hypogastric plexus (sympathetic n.)
S_1
S_2
S_3
S_4
Pelvic plexus
Pelvic splanchnic n. (parasympathetic n.)
Pudendal n.

FIG. 5. Autonomic and somatic nerve supply to the male urogenital system.

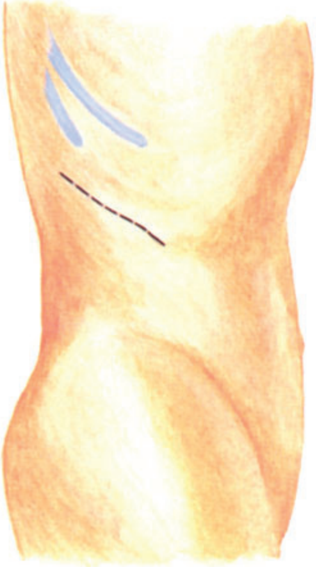
Operative Techniques

31. Foley "Muscle Splitting" Incision

As the following sequence of illustrations depicts, muscle splitting could be more appropriately termed muscle separation.

31-1. The *line of incision is oblique* from the mid portion of the 12th rib to the anterosuperior spine of the iliac crest. The operating table is slightly flexed and the lumbar muscles underlying the operative area are under only slight tension.

31-2. The *muscles forming Petit's triangle*—latissimus dorsi (posterior border) and external oblique (anterior border) *are bluntly separated* to expose first the internal oblique and, once through this layer, the transversalis fascia. The fascia is incised to expose adipose tissue in the retroperitoneal space.



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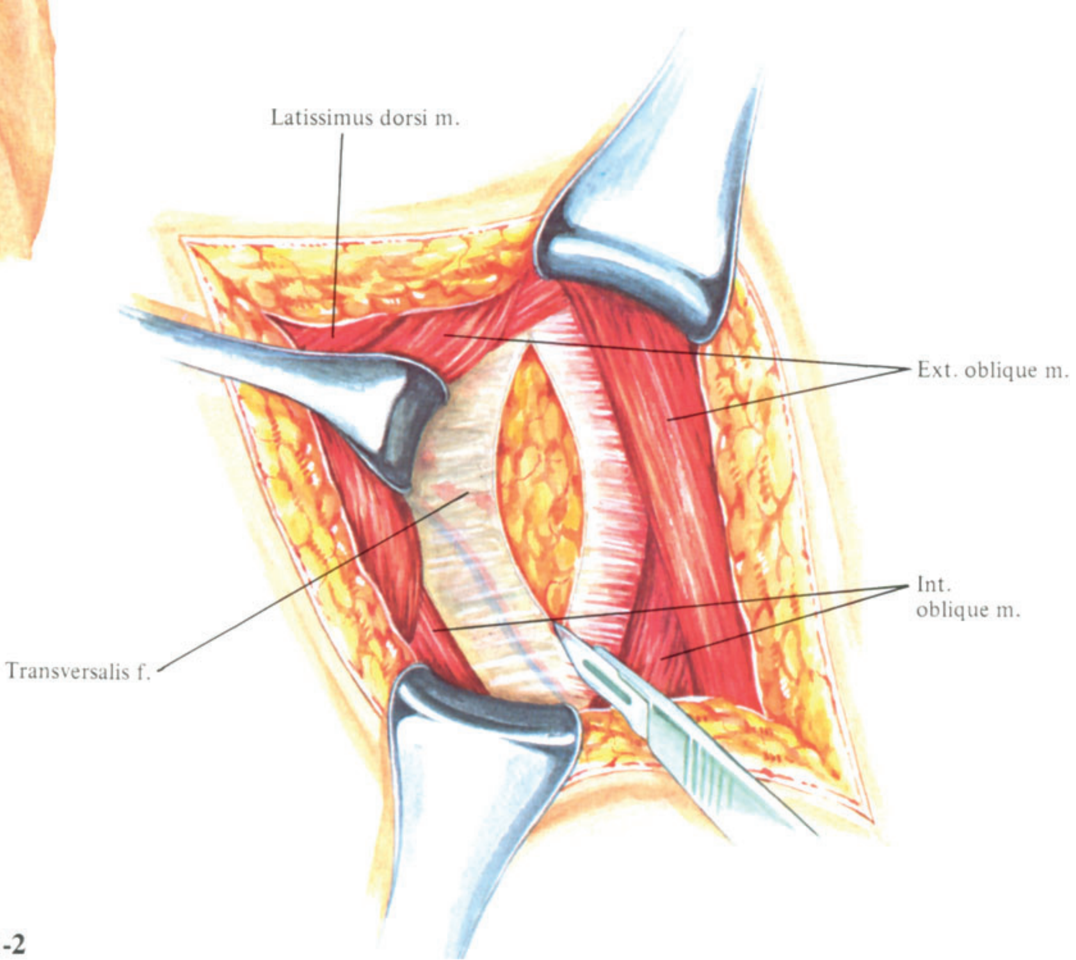


31-2

31-3. *The upper ureter containing the calculus is exposed and isolated.* A small Penrose drain or umbilical tape is placed around the ureter superior to the calculus to prevent retrograde migration of the calculus. The ureteral incision as indicated by a dotted line is made over the calculus. When the calculus is withdrawn by forceps, a ureteral catheter (5 French) is passed in both directions to the level of the renal pelvis and bladder.

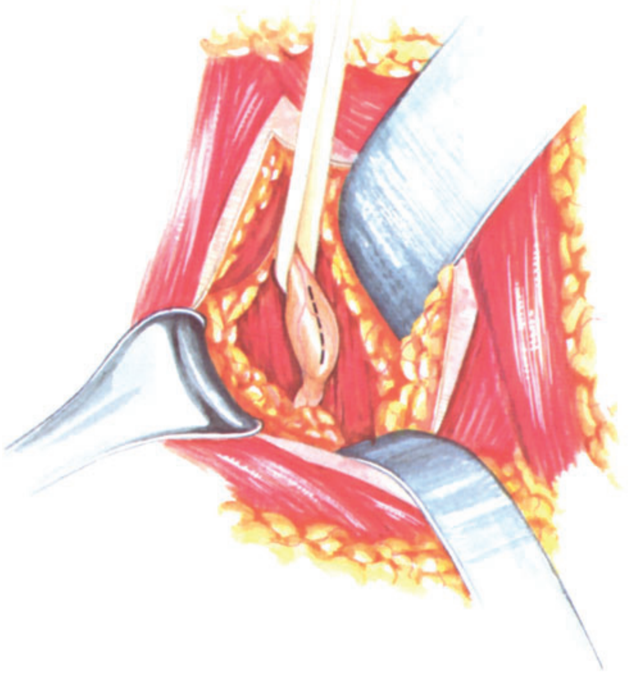
Periadventitial ureteral sutures (4-0 chromic catgut) are used to reapproximate the edges only if a gaping ureteral incision is observed. Insertion of a Penrose drain before final closure is mandatory. The drain is shortened or removed in 2–3 days.

An alternative approach to the mid-ureter is extraperitoneal and can be started by using an incision that is also used for left varicocelectomy (high left spermatic vein ligation). On the right a nearly horizontal skin incision may be employed. The abdominal muscles are separated along the lines of their fibers. External oblique, internal oblique, and transverse abdominal are separated bluntly with large curved clamps or with the fingertips. The peritoneum is reflected medially with a Deaver retractor or a sponge on a ring forcep. As the dissection is carried medially across the psoas major muscle, the transversalis fascia surrounding the spermatic vein will be encountered first. More medial retraction and posterior dissection will expose the ureter. The calculus is palpated. A small Penrose drain or a Babcock clamp is passed around the ureter superior to the calculus to prevent upward migration.

32. Vertical Lumbar Approach with Minimal Muscle Dissection for Upper Ureteral Calculus

32-1. *Line of incision* through Petit's triangle.

32-2. *Cross section at level of mid-right kidney.* The arrow indicates the route of minimal muscle dissection.



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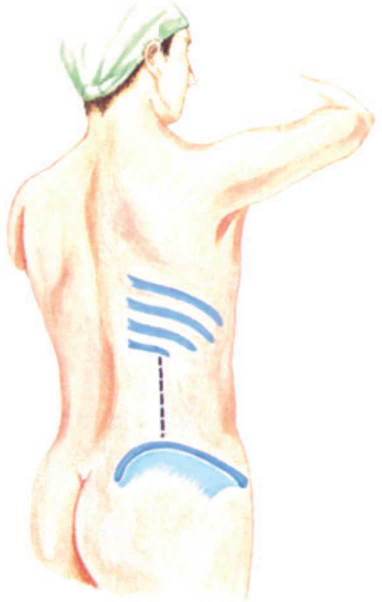

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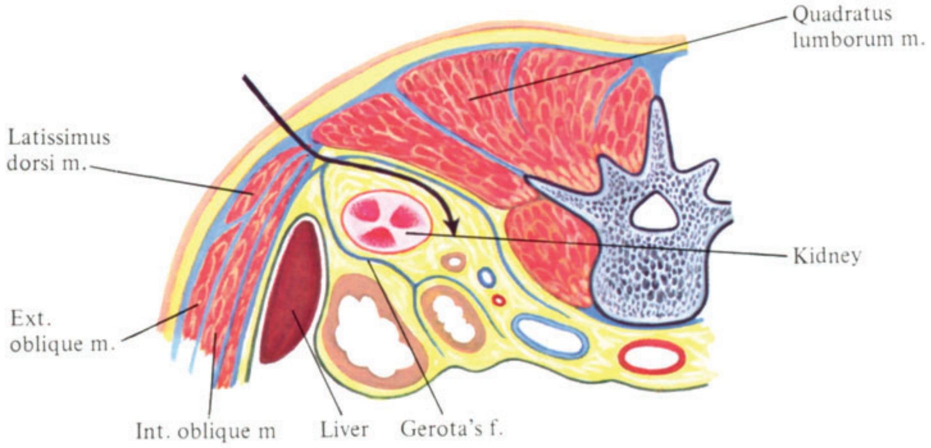

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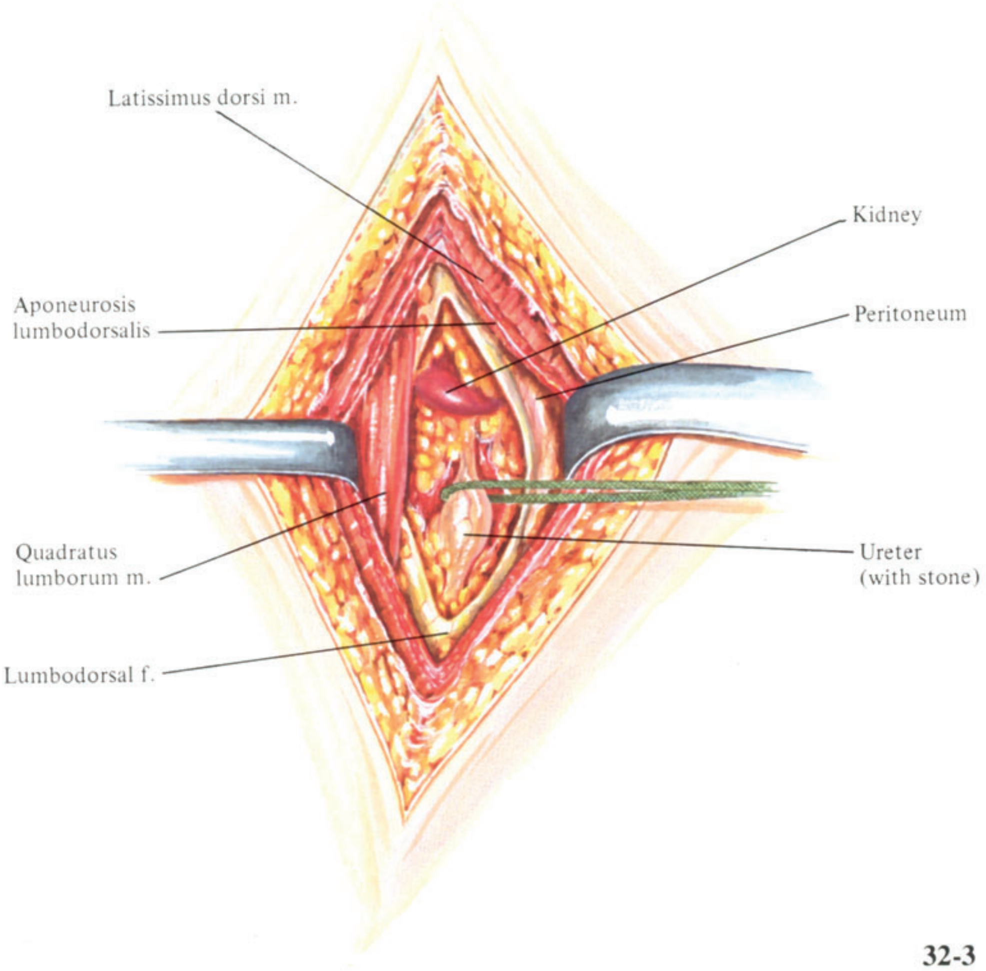


32-3

32-3. *The dilated ureter containing the calculus is exposed.* An umbilical tape is placed superior to the calculus to prevent retrograde migration to the renal pelvis. The procedures for removing the calculus and effecting closure have been described in the techniques for the Foley ''muscle splitting'' incision.

33. Ureterolithotomies of Lower Ureter

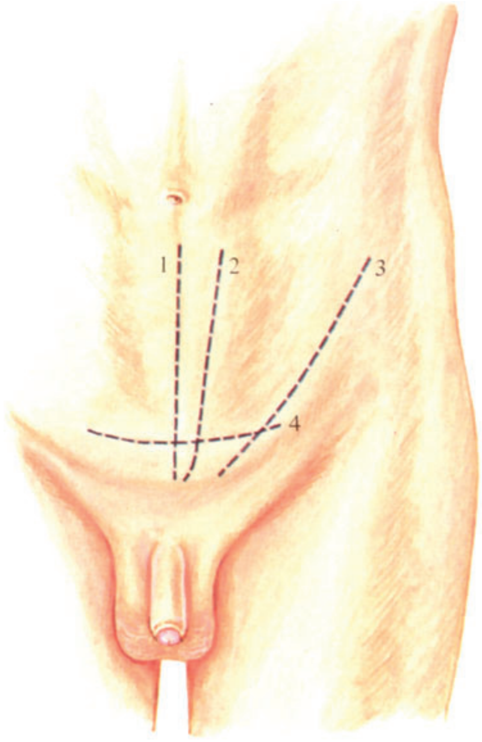
33-1. The following *lines of incision* can be used depending on the location of the calculus: 1) vertical midline, 2) paramedian, 3) oblique, 4) transverse.

A discussion of the anterior abdominal wall is appropriate at this point. The rectus abdominis muscle extends from the thorax on each side to the pubis. It originates from the pubic crest and anterior pubic ligament. It inserts along the anterior surface of the fifth, sixth, and seventh costal cartilages. The medial border is separated from that of its fellow by the linea alba. The anterior surface of the muscle has three tendinous insertions which provide added strength. They are located at the costal cartilage, the umbilicus, and between the two.

The sheath of the rectus abdominis can best be discussed by regions, as follows:

1. Above the costal margin the sheath is incomplete; the anterior wall is the aponeurosis of the external oblique; no posterior wall exists. Therefore the muscle lies on cartilage.
2. From the rib margin to the midpoint between umbilicus and pubis, the sheath is complete. The internal oblique aponeurosis divides at the lateral border of rectus muscle into anterior and posterior layers.
   a. The anterior wall of the sheath consists of the aponeurosis of the external oblique plus the anterior layer of the internal oblique aponeurosis.
   b. The posterior wall consists of the posterior layer, aponeurosis of internal oblique and the aponeurosis of the transversus abdominis muscle and the transversalis fascia. The transversus abdominis muscle, which extends behind the rectus, is muscular to the midline.

   The posterior sheath ends midway between the umbilicus and the pubis. The arched lower border or sheath is the line of Douglas. Inferior to this border, the internal oblique aponeurosis does not di-



33-1

vide but goes anterior as a common sheath. The inferior epigastric artery enters the sheath of rectus abdominis by crossing this edge.

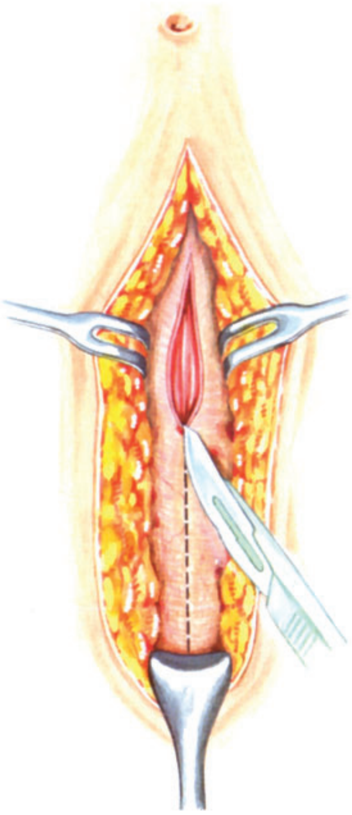
3. From midway between the umbilicus and the pubis to symphysis pubis, the anterior wall is formed by the aponeurosis of the external and internal oblique muscles plus the transversus abdominis muscle. The transversus abdominis and the internal oblique are fused. The external oblique does not fuse until it reaches midline. The posterior wall is formed by the transversalis fascia.

In a female patient an oblique or a transverse incision is probably the best approach to avoid the uterus and adjacent vascular supply (see Figs. 2 and 3). The following illustrations depict the surgical approach to the right lower ureter.

33-2. *A vertical midline incision is carried through the fascia.*

33-3. *The muscles and underlying peritoneum are retracted* medially, exposing the retroperitoneal fat.

33-4. *The dilated portion of the right ureter containing a calculus is exposed.*



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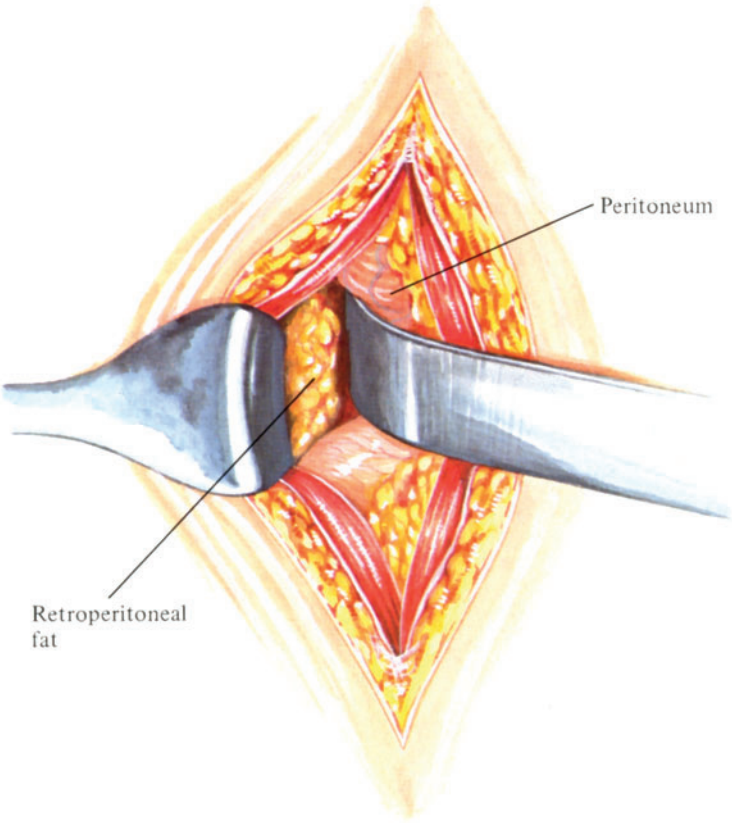

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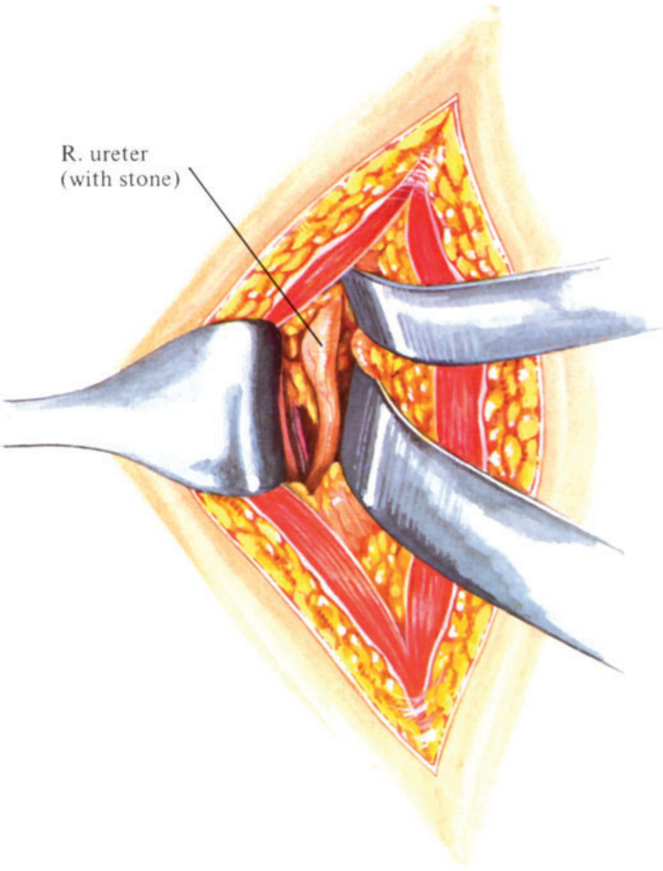


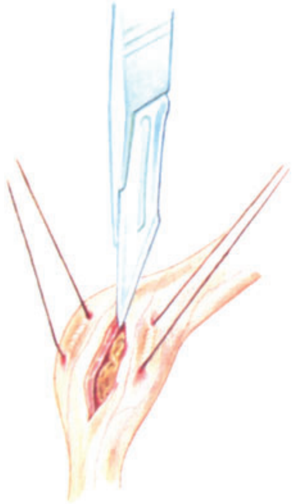
33-4

33-5. Stay sutures improve exposure.

33-6. *The stone is removed.*

33-7. *The ureter is catheterized inferiorly.*

33-8. Interrupted 4-0 or 5-0 chromic catgut sutures are used for closure of the ureter.



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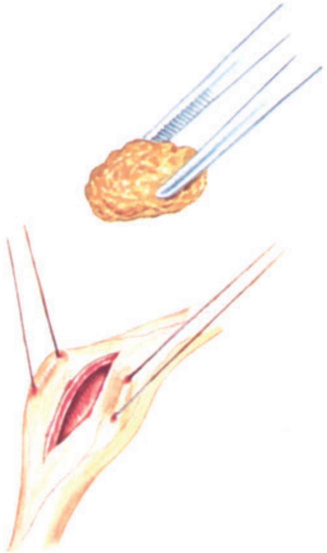

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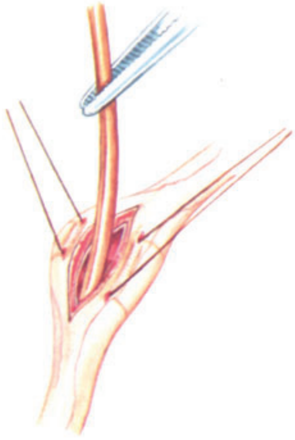

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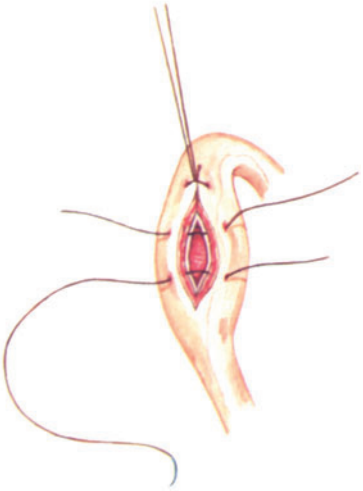

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34. Ureterolithotomy by Transvesical Approach

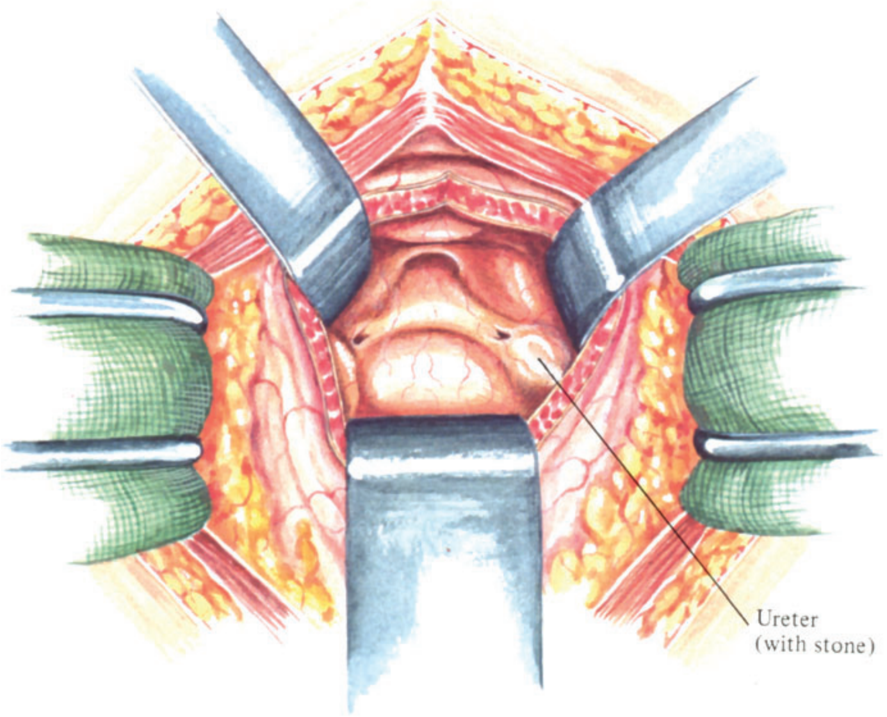
A vertical low midline incision is made, and the fascia is incised (see Figs. 33-1 and 33-2). The rectus abdominal muscles are separated laterally from the midline. The bladder, which has been previously distended, is opened along the anterior midline surface.

34-1. *Exposed inner surface of the bladder,* as seen from a surgical vantage. Because of its intramural location on the right, the calculus can be palpated.

34-2. *An incision is made through bladder mucosa into the ureter.* Stay sutures assist in exposure.

34-3. *The stone is removed.*

34-4. *The ureter and bladder mucosa are closed* with interrupted 4-0 chromic catgut sutures.



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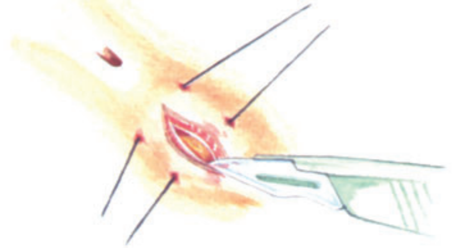

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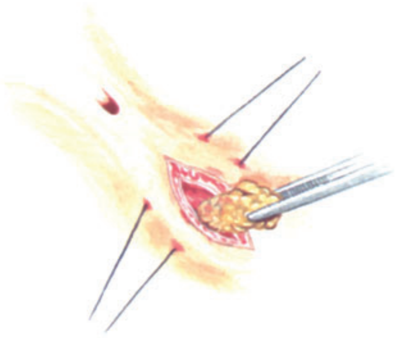

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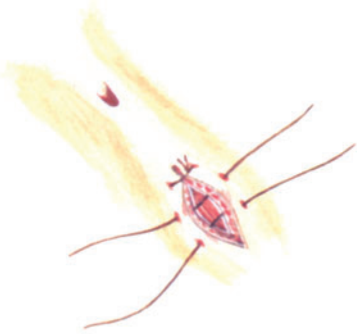


34-4

35. End-to-End Ureteroureterostomy

Damage to a ureter, inadvertently caused by previous surgery, or due to penetrating wounds may require excision of a short ureteral segment. Clinical experience has indicated a high incidence of ureteral damage in the female undergoing gynecologic surgery. The following illustrations demonstrate the two best methods of anastomotic repair.

35-1. *The short damaged ureteral segment is excised, the remaining ends are trimmed on a bias, and reapproximated.* Anastomotic closure is accomplished with 4-0 or 5-0 chromic catgut sutures, depending on ureteral size.

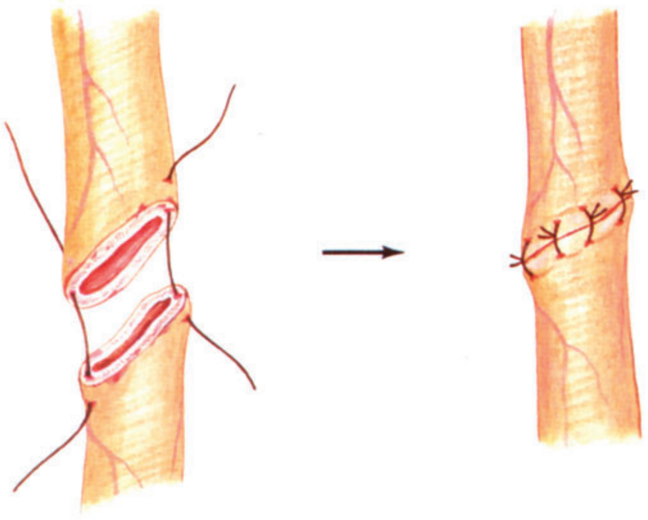
35-2. In this alternative, *end-to-end anastomosis is effected by excising the short damaged ureteral segment, securing the remaining ends with stay sutures,* and examining the tissue. The ureteral lumen is widened on opposite ends (180° apart) by incising each wall longitudinally (approximately 8 mm). Ureteral ends are reapproximated and secured using 4-0 or 5-0 chromic catgut.

In all instances of ureteral repair a Penrose drain is inserted and secured for 3–5 days.

36. Transureteroureterostomy[1]

Unilateral damage to a long lower segment of ureter may occur. Under such circumstances anastomotic repair may be required.

36-1. This *schematic shows crossover of the upper right ureter* after removal or ligation of the damaged segment. Note that this is done by an end-to-side anastomosis.



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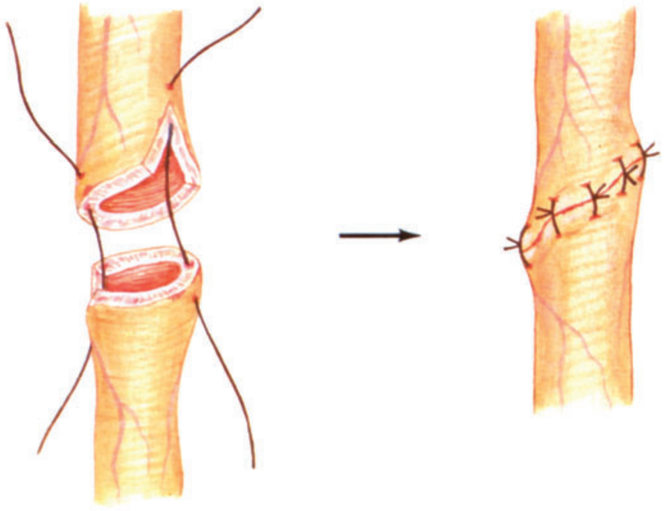

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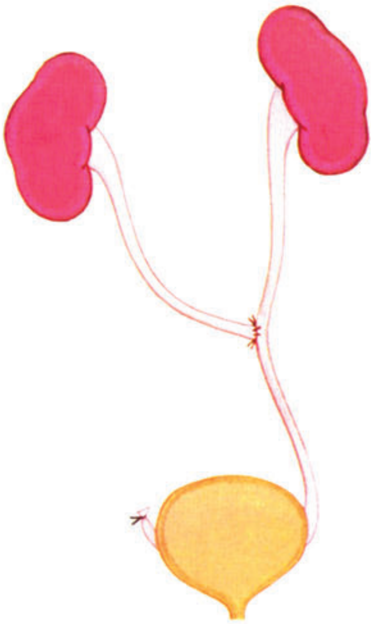
36-2. The surgical field is reached through a transabdominal approach. *Both middle ureters are located by separate retroperitoneal dissections.* The end-to-side transureteroureteral anastomosis is performed in the retroperitoneal space. A small Penrose drain facilitates the isolation of the left ureter and assists in exposing the anastomotic junction.

36-3. If necessary, *the anastomosis of a contralateral ureter to the healthy kidney may be used.* A situation such as this could be surgically handled by autotransplantation, by placing the left kidney in the right iliac fossa.



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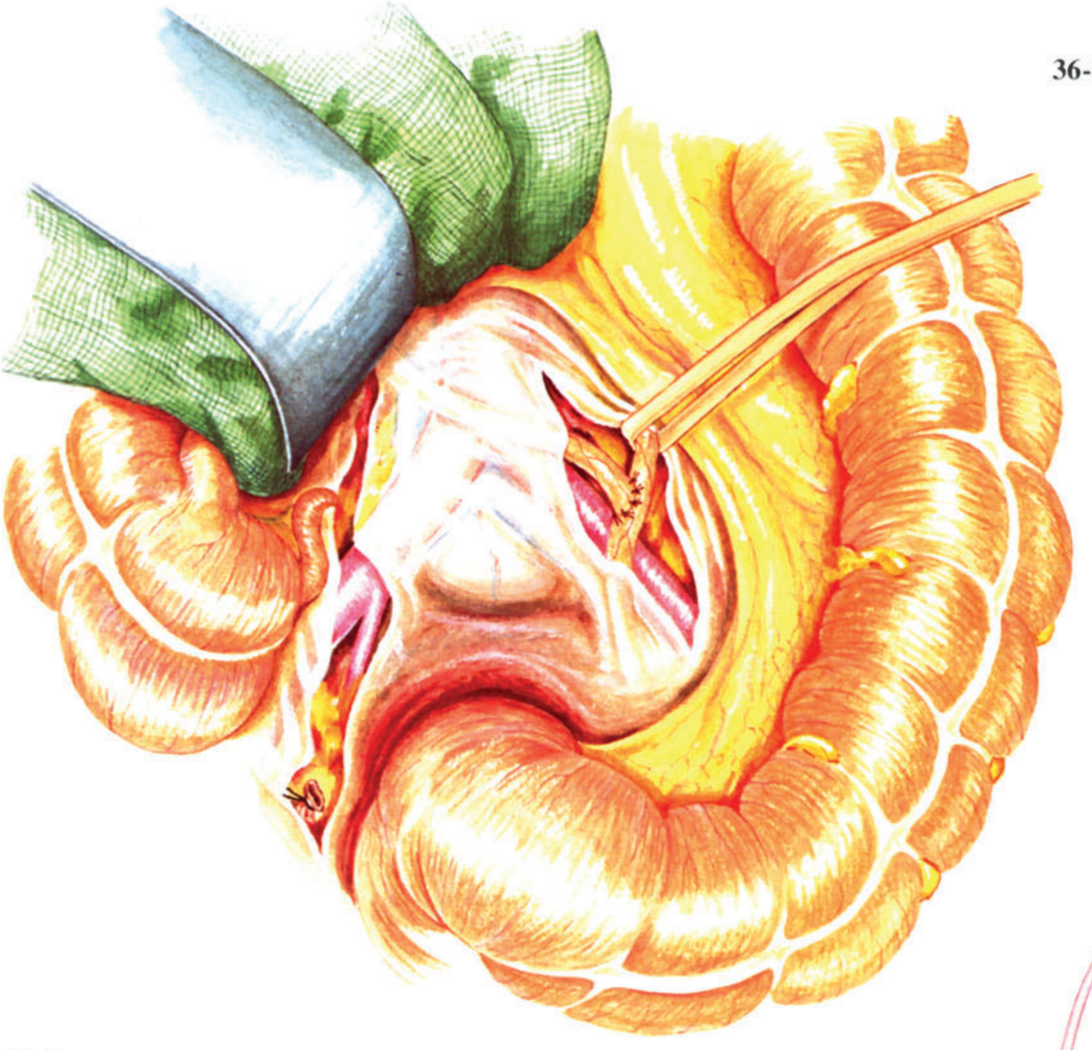

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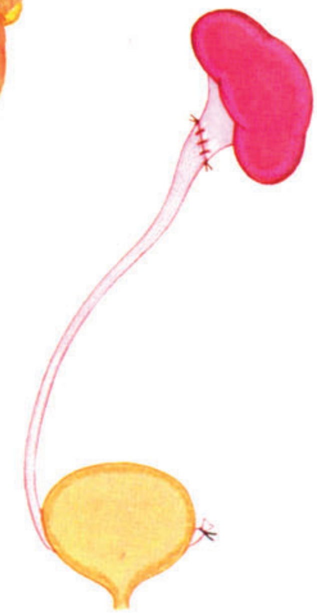

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37. Unilateral and Bilateral Cutaneous Ureterostomy

This procedure can be useful for patients suffering renal insufficiency or for palliation in patients with carcinoma. For long-term urinary diversion, the procedure is contraindicated because of infection and progressive narrowing of the stomas.

37-1. *Potential sites for placement of ureteral stomas* (circles on left and right sides). In the midline inferior to the umbilicus, both ureteral ends can be joined and brought out as a single stoma.

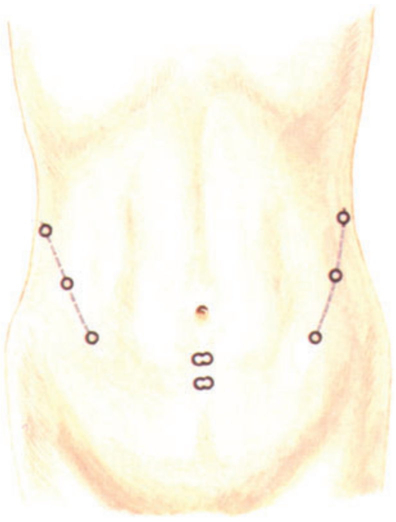
After potential sites on the skin are marked, a vertical midline transabdominal incision is made to allow access and to conveniently locate both upper ureters. The peritoneum and fascial lining lateral to the ascending and descending colon are incised longitudinally, allowing medial retraction of the large bowel, for full exposure of the ureters. The ureters are severed at the most inferior point to allow optimum placement without tension. The lower ureteral ends are ligated, using 2-0 chromic catgut.

37-2. The ureter is freed. *A clamp is used to initiate the new ureteral pathway* to a previously selected stomal site. A small skin incision is made and carried through the fascia to allow the clamp free access to the skin opening. A rubber ureteral catheter (6 French) can be grasped and drawn into the peritoneal space, where it is introduced into the ureter and appropriately tied.

37-3. *The catheter is grasped and gently withdrawn* through the newly created tunnel. Two 3-0 chromic catgut sutures are used to secure the ureter (periadventitial ureter to fascia) at the stomal site.

37-4. The *catheter is withdrawn.* Redundant ureter is excised, and the ureteral stoma is widened.

37-5. *For final completion of the stoma interrupted 4-0 chromic* catgut is used. If necessary, a Penrose drain is brought out retroperitoneally through a separate incision and secured for 24 hours. The procedure is repeated for the opposite side.



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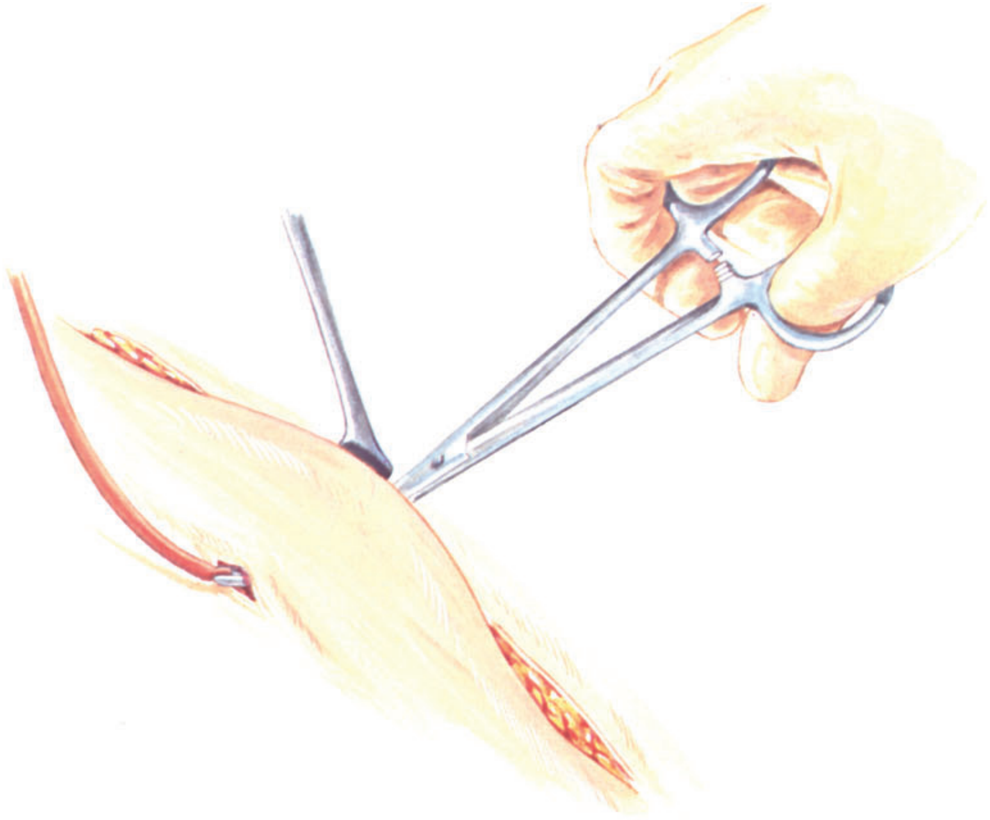

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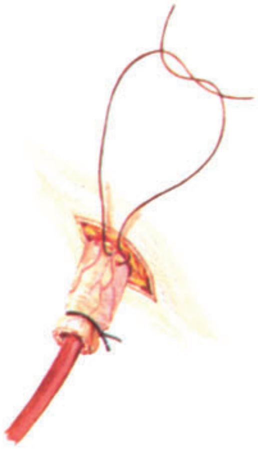

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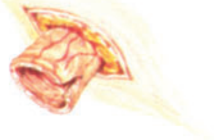

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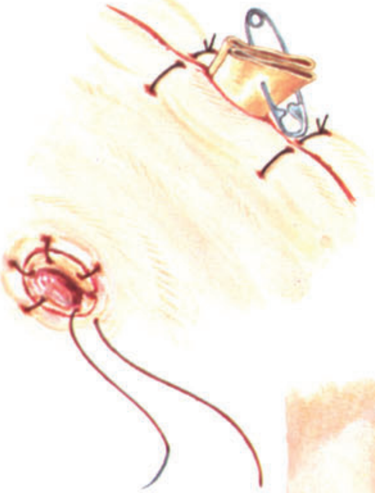

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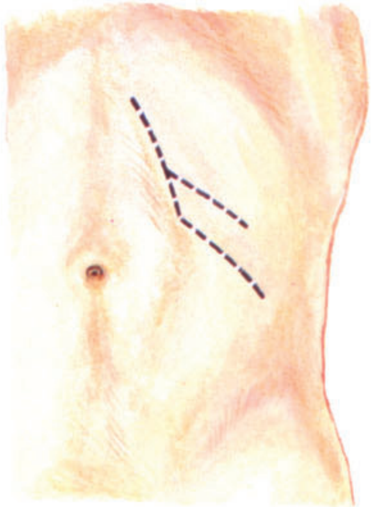


38-1

38. Unilateral Cutaneous Ureterostomy[3]

The advantages of this approach over the foregoing method include the extraperitoneal exposure of the ureter, and formation of a skin nipple for more convenient stomal management.

38-1. The *incisions are made for ureteral access and creation of a skin flap*. The ureter is brought out through the peritoneum, and is freed and severed. The inferior end is ligated. A ureteral catheter (6 French) is introduced, secured, lifted, and withdrawn to the mid-incision site.

38-2. *The ureter is in place for creation of the stomal nipple.* Note the presence of a Penrose drain.

38-3. *The nipple has been formed,* and the stomal site has been secured with interrupted sutures (4-0 chromic catgut).

39. Bilateral Cutaneous Ureterostomy

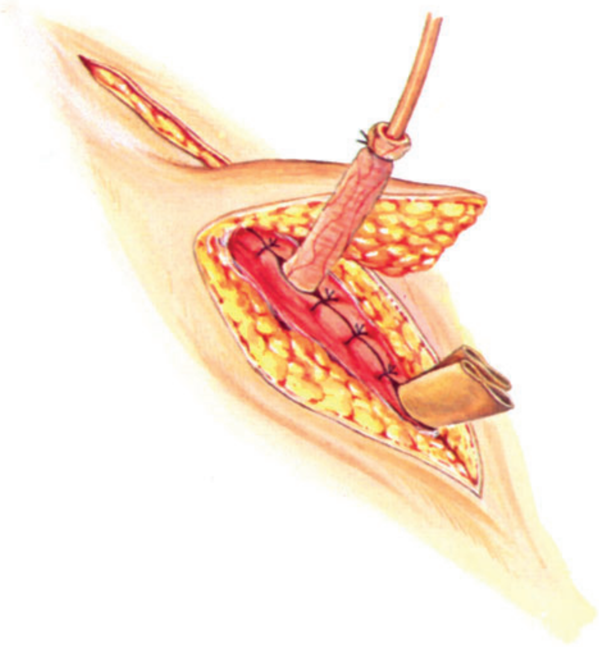
See Figure 37-1 for the potential site of midline ureteral stomal placement. A vertical midline transabdominal incision is made from the mid-epigastrium to the umbilicus.

39-1. The schematic demonstrates the selected *location of the combined stomal site,* and the approximations of the lower freed ends of the ureter. The development of the stomal tunnel is facilitated by intraperitoneal access to this region. An incision is made as indicated by the dotted line. The ureters are brought through the opening. This maneuver is facilitated by the use of stay sutures.

39-2. Each ureter is incised longitudinally for 2 cm in a line facing each other. The *newly created common posterior stomal wall* is reapproximated and sutured as shown.

39-3. *The stoma is large and broad* enough to be secured directly to the skin margin and appropriately sutured.

A urinary collection bag (ileostomy bag) can easily be placed over the new stoma.



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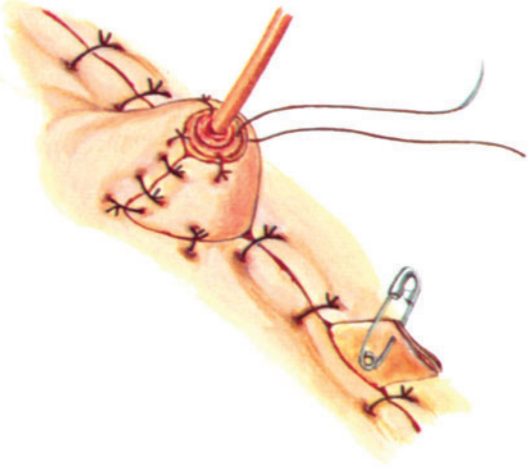

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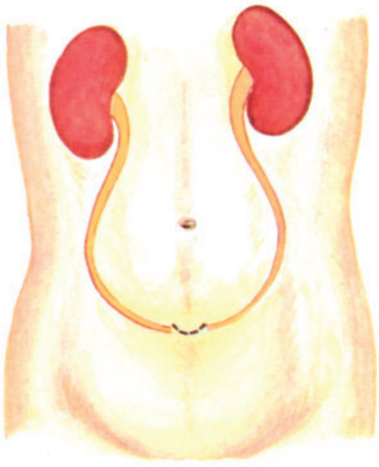

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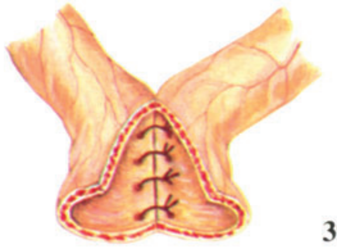

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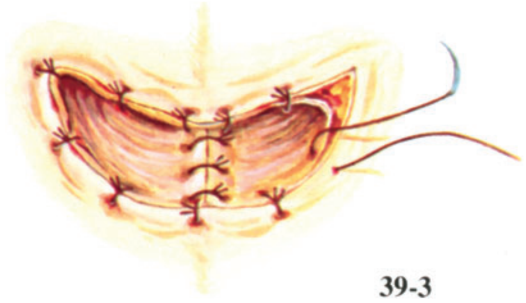


39-3

Routine Bowel Preparation for Bowel Surgery

For large bowel surgery the patient is hospitalized 72 hours prior to surgery; in selected well-motivated patients the preparation can be started at home. For small bowel surgery the patient is hospitalized 48 hours prior to surgery.

1. Low residue diet: begun and continued during the preoperative period
2. Enemas: (tap water) once daily until day before surgery, when enemas are given b.i.d.
3. Laxative: 16 ml aqueous solution of sodium phosphate (Phospho-soda) b.i.d. throughout preoperative period
4. Antibiotics: 500 mg neomycin and 250 mg tetracycline (orally) q.i.d. until surgery. An alternative antibiotic protocol includes 1 gm neomycin and 1 gm erythromycin base, which are given three times on the day before surgery. Both medications are given orally at 1300, 1400, and 2300 the day before surgery.

40. Bilateral Ureterosigmoidostomy (Goodwin Procedure[4])

Goodwin recently stated that this operation "is due for a renascence."[5] We agree.

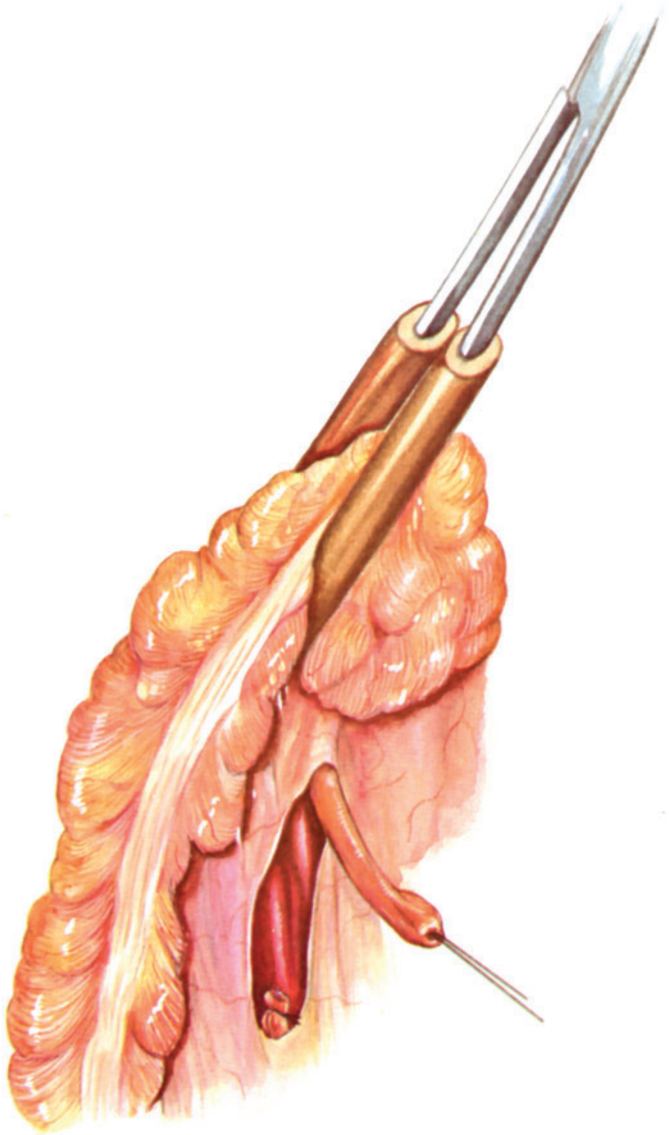
Patient selection is important in this procedure. The ureters must be of normal caliber. Total renal function should be close to normal levels. A competent anal sphincter must be present. This can be determined by introducing a fluid load of 5–7 ounces through the anal sphincter. Any fluid leakage would preclude use of the procedure. If megavoltage irradiation is contemplated to the pelvic bed, e.g., in infiltrative bladder carcinoma, then this operation is contraindicated. However, an alternative with modifications can be substituted. A sigmoid segment of colon can be fashioned and isolated to serve as a urinary conduit. The distal end is brought to the skin. The ureters are implanted through a submucosal tunnel, preventing urinary regurgitation.

The obvious advantages of this procedure are 1) no external urinary collecting device is needed, and 2) the ureteral antireflux procedure discourages reflux and prevents pyelonephritis.

Preoperative Considerations. Adequate bowel sterilization procedures are mandatory. An antibiotic—neomycin—for 48 hours before surgery is mandatory. The generous use of enemas is necessary. A low-residue diet is of assistance.

Incision. A vertical midline transabdominal incision is extended from the midepigastrium, curving around the umbilicus and continuing inferiorly for 10 cm. The peritoneal cavity is entered, and routine inspection and palpation of the abdominal contents are carried out.

The small bowel is placed in a moist plastic bag, the noose in the bag is tightened at the base of the small bowel mesentery. The small intestine and bag are lifted out of the abdominal cavity and placed on the right anterior abdominal wall.



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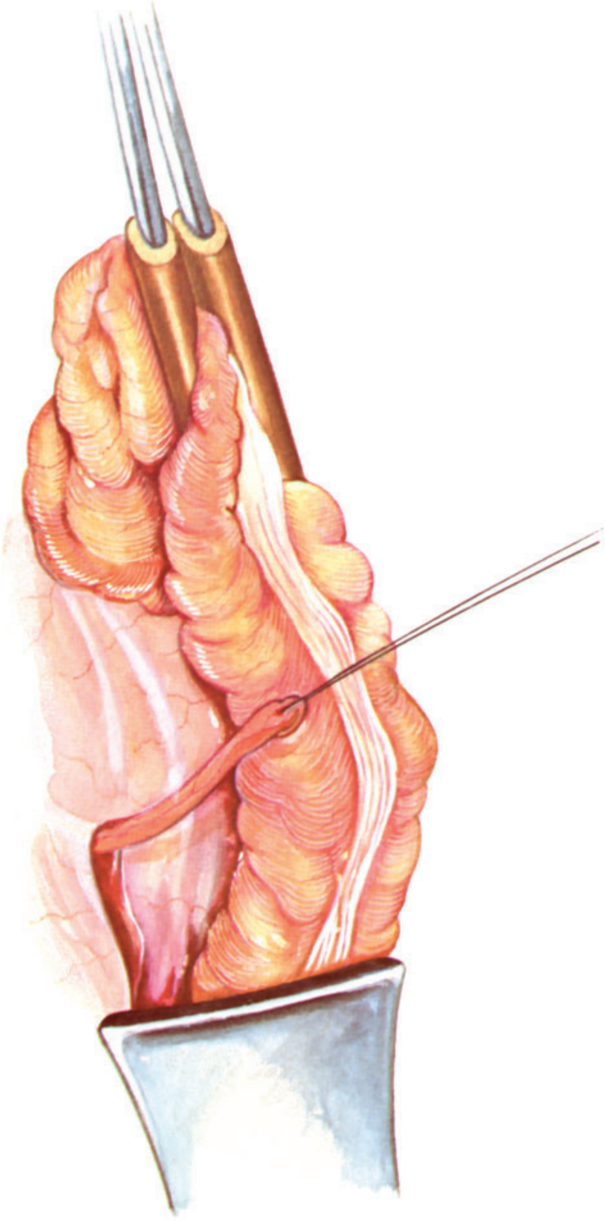

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The posterior peritoneum is incised longitudinally over each midureter. The ureters are found as they cross the bifurcation of the common iliac arteries. The ureters are freed inferiorly, clamped, transected, and ligated inferiorly. The free ureteral ends are secured with stay sutures and delivered into the peritoneal cavity.

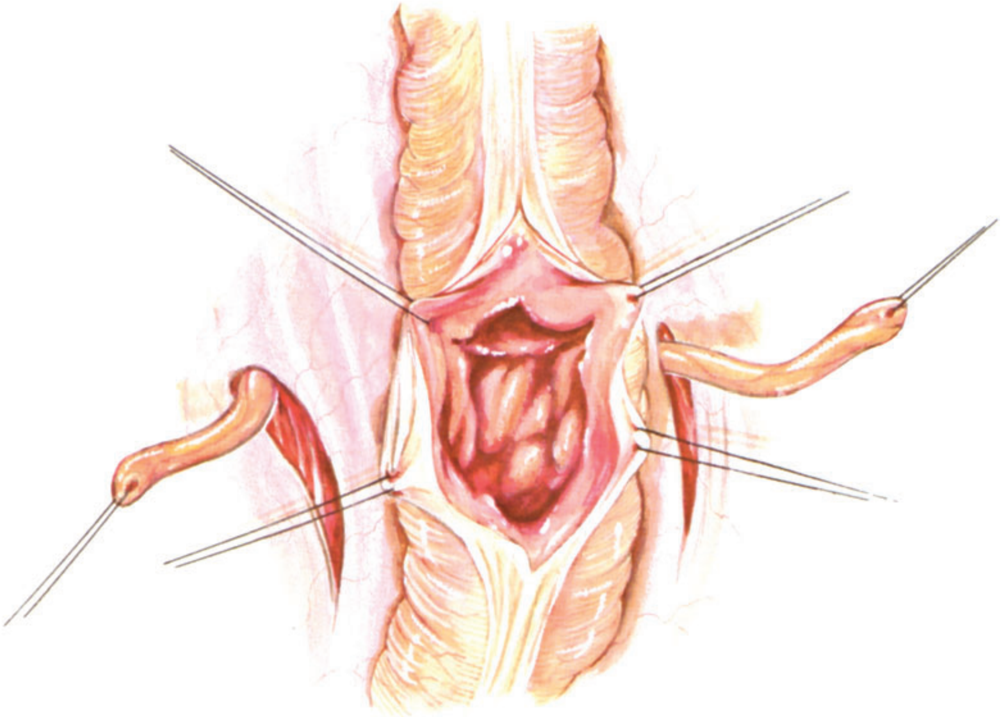
40-1. *The contiguous sigmoid colon at the promontory of the sacrum is elevated* by means of a rubber-shod intestinal clamp. The freed left ureter is seen.

40-2. *The right ureter* is seen.

40-3. *The sigmoid colon is incised anteriorly* along the tenia. Stay sutures are strategically placed. The bowel lumen is readily visible.

40-4. *The sigmoid mucosa has been incised posteriorly* in two areas to accommodate the ureters. A right-angle or curved cystic-duct clamp can be used to dissect through the bowel wall and adjacent posterior serosa. The stay suture is grasped, and the ureter is gently drawn through the posterior wall. A similar maneuver is used for the contralateral ureter. It is important to prevent kinking, tension, or twisting of the ureters as each courses through the mesosigmoid and posterior sigmoid segment of the bowel.

40-5. *A submucosal tunnel is created inferior to the point of ureteral insertion.* Four stay sutures assist in marking the length of the tunnel (tunnel length should be six times the diameter of the ureter). A small Penrose drain is grasped.



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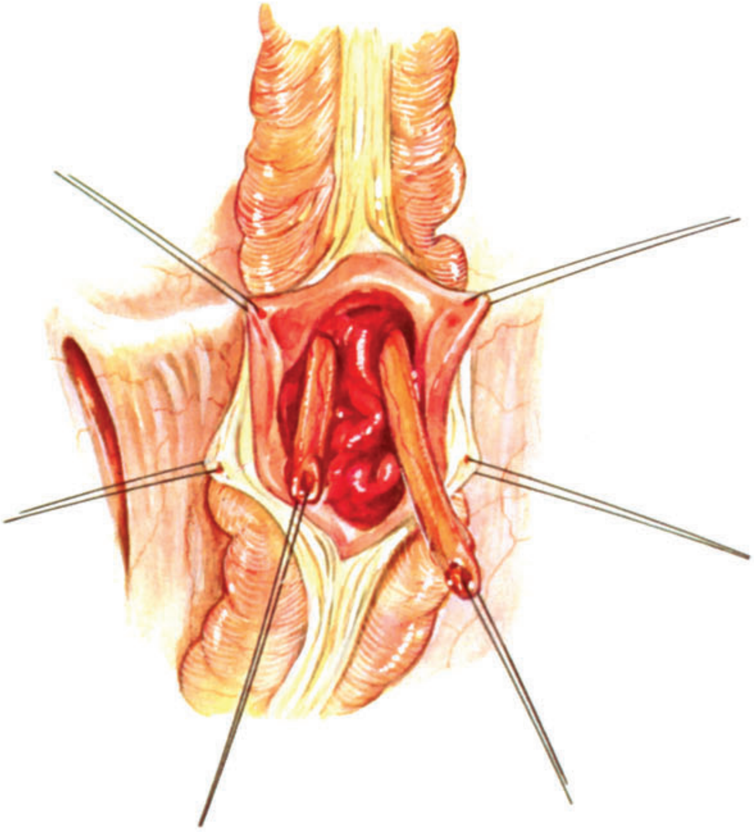

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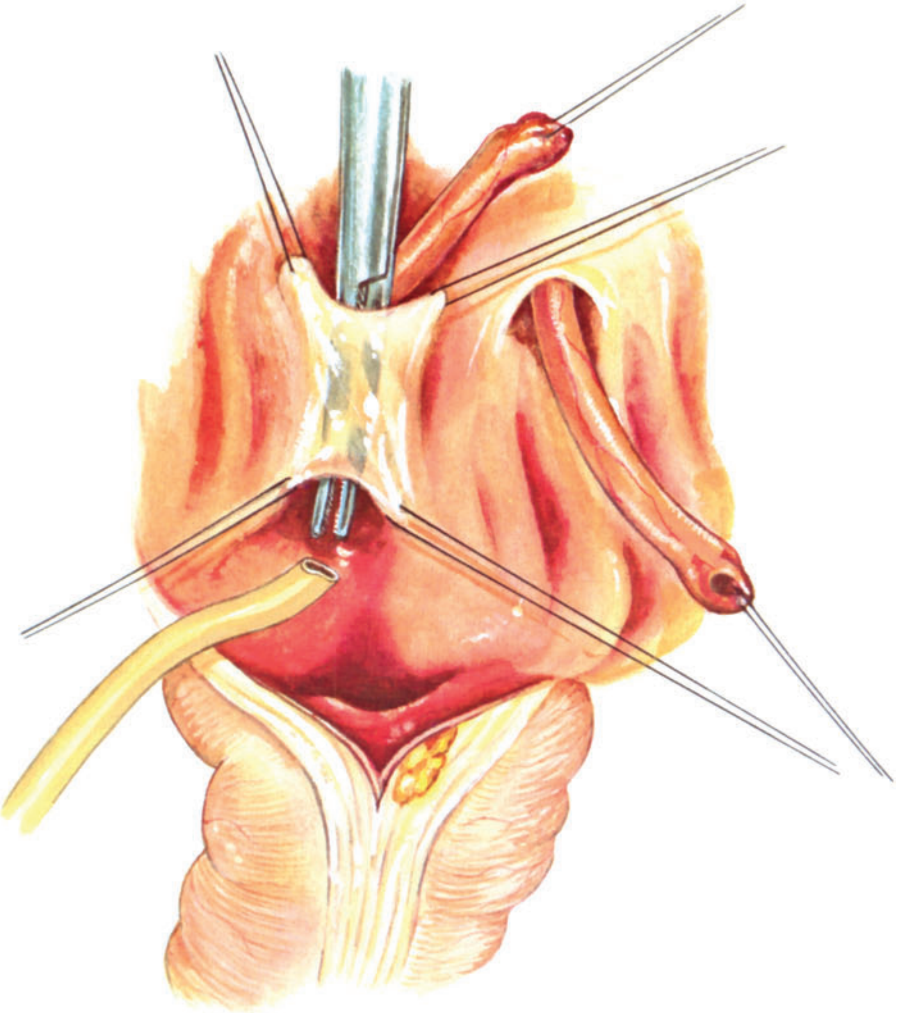

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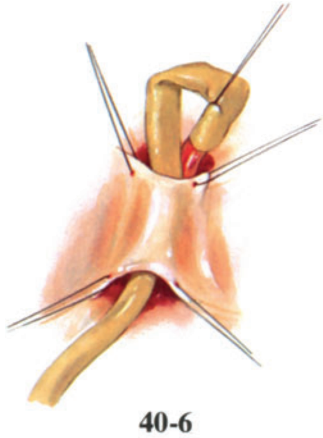
40-6. *The Penrose drain is pulled through the tunnel superiorly* and positioned so that the open end caps the end of the ureter. A single suture is used to secure the junction.

40-7. *The Penrose drain is grasped and slowly pulled back out of the tunnel,* bringing along with it the secured ureter. Note that stay sutures placed superiorly help to flatten redundant mucosa.

40-8. *The superior opening in the mucosa is sutured* (4-0 chromic catgut). The terminal point of the ureter in the sigmoid lumen is fixed by interrupted 4-0 chromic catgut sutures as shown. A ureteral stent (5 French pediatric feeding tube) is introduced into the ureter to rule out obstruction. The contralateral uretersigmoid anastomosis is carried out in the same manner.

40-9. *The ureterointestinal anastomosis is completed on both sides.* The superior ends of the ureteral stents reside in the renal pelvis.

To accommodate the inferior position of the stents, a sterile rectal tube is passed to the open sigmoid. The stents are tucked within the lumen, and the rectal tube is withdrawn. Ureteral stents remain in place for 3–4 days.



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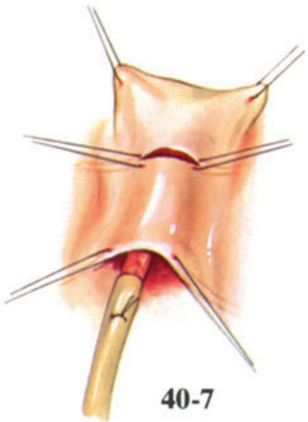

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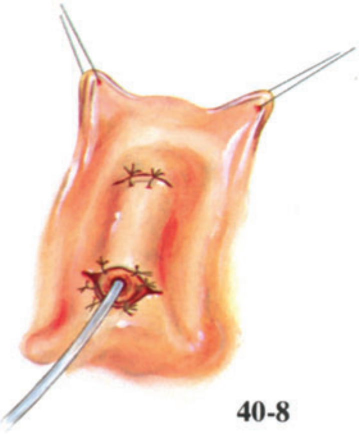

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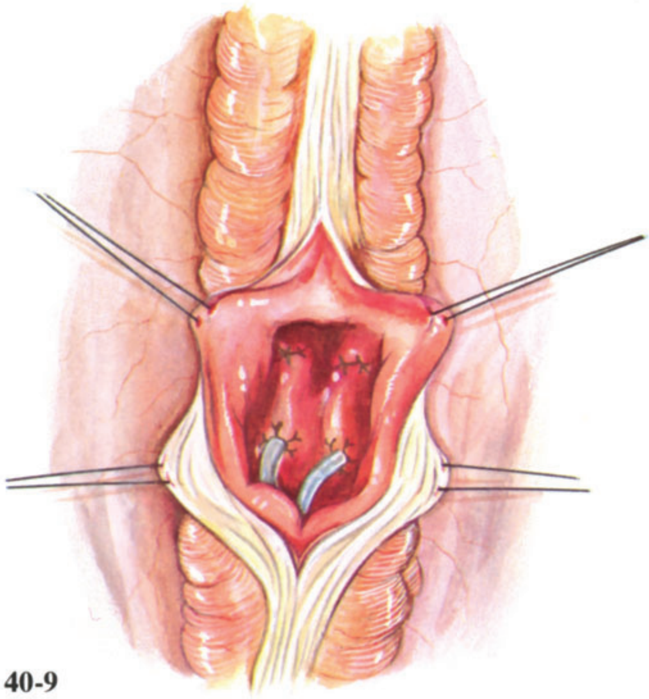

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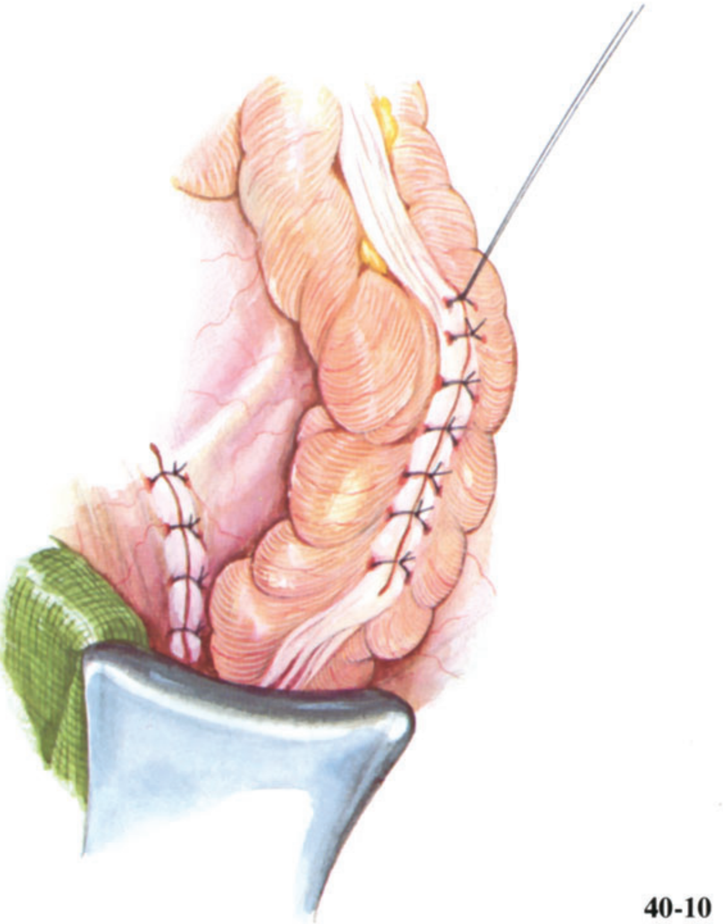

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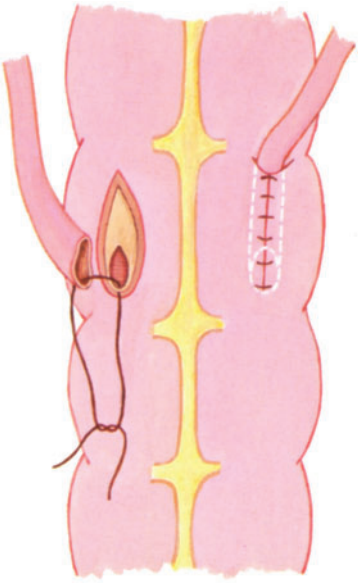
40-10. The sigmoid and peritoneal opening are closed. Closure of the sigmoid is performed in two layers. The inner mucosal lining is reapproximated and sutured with running 3-0 chromic catgut. The tenia is reapproximated with interrupted 3-0 silk sutures. The peritoneal openings are sutured with 4-0 chromic catgut.

Closure of the abdominal wound is performed in the standard manner. A Penrose drain may be placed retroperitoneally to the posterior area of the sigmoid closure for 1–2 days.



41-1

41. Ureterosigmoid Anastomosis from Outside the Sigmoid

41-1. Schematic of an *anastomosis through the posterolateral sigmoid.* The ureter is being sutured to bowel mucosa (at left). After the anastomosis is completed, the adjoining ureter is laid in the trough between submucosa and longitudinal muscle layers and the trough is closed (at right).

42. Other Ureterointestinal Anastomotic Procedures

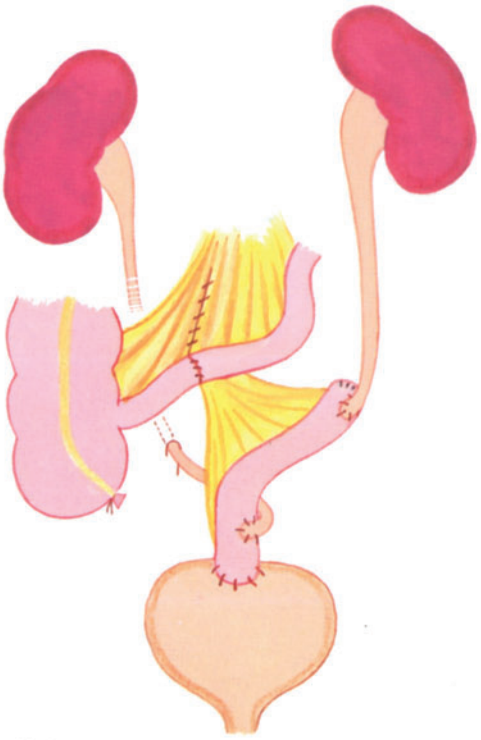
A ureteral substitute may be formed from a segment of ileum.

42-1. Schematic of *ureterointestinal anastomosis to an isolated segment of ileum.* Urine is transported in isoperistaltic fashion. The distal tip of ileum is anastomosed to the posterior bladder wall.

42-2. *In this ipsilateral ureteral anastomosis,* a segment of ileum serves as a ureteral substitute.

42-3. *Total ureteral substitution* is accomplished by an isoperistaltic segment of ileum.

42-4. *A segment of ileum serves as a common ureter for both kidneys.* The left renal pelvis is sutured end to end; the right renal pelvis is end to side, and the tip of the ileum is fashioned into a cutaneous stoma. The ileal segment transports urine from left to right in isoperistaltic fashion.



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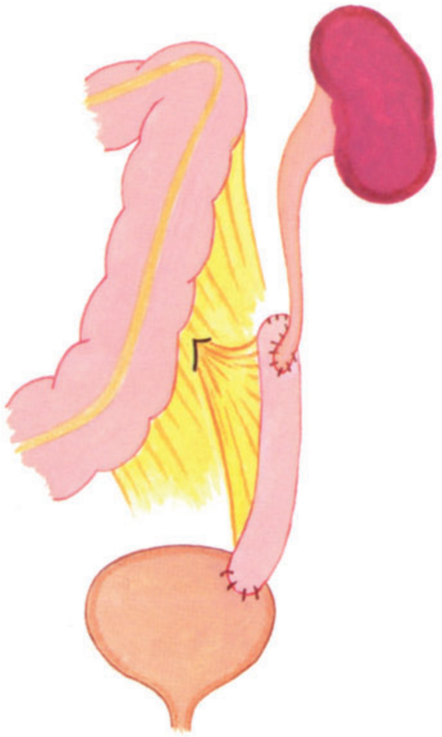

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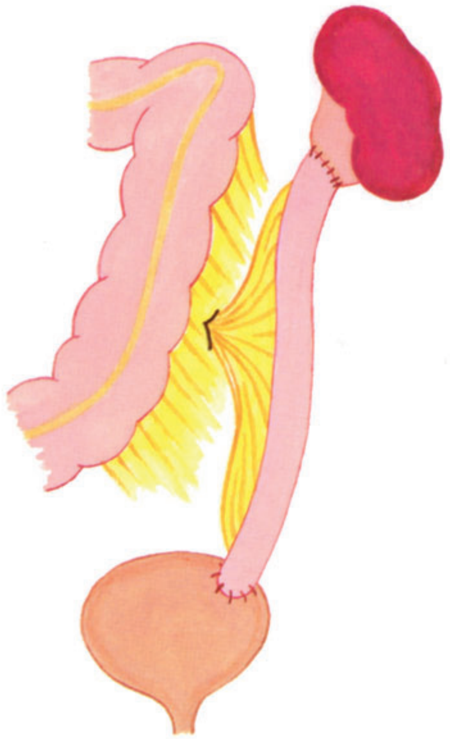

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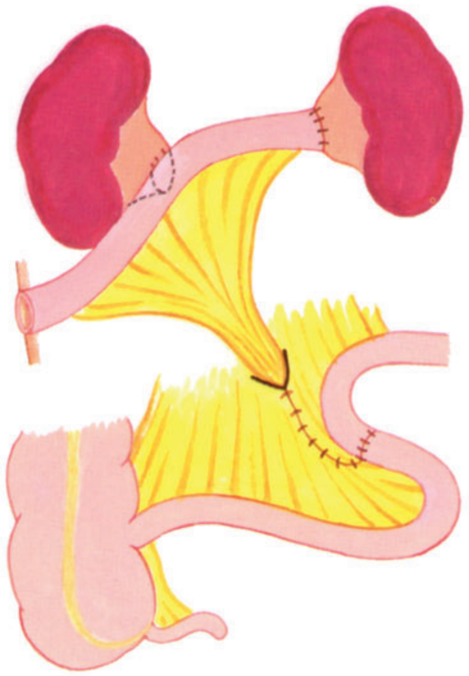


42-4

Vesicoureteral Antireflux Procedure

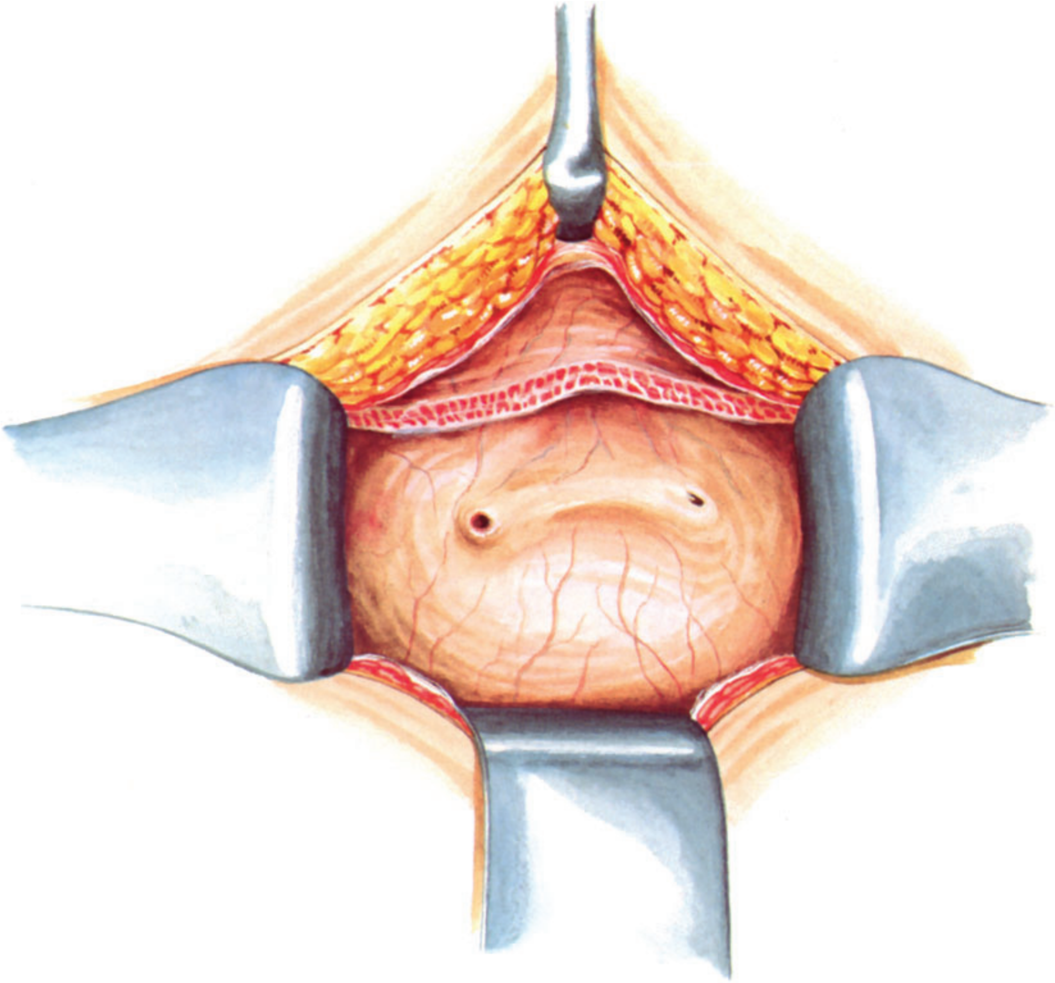
43. Politano–Leadbetter[9]

General Considerations. This procedure is most often performed in children. The child usually has suffered recurrent urinary tract infections. While the child is undergoing treatment, the voiding cystourethrogram (VCU) will demonstrate low-pressure reflux. An intravenous urogram (IVU) is obtained to rule out obstruction due to congenital anomalies. Urethral calibration and cystoscopy (urethroscopy) are carried out under anesthesia as a separate procedure to rule out significant urethral outlet obstruction. Such obstruction is dilated or treated at this time.

Recurrent urinary tract infection is treated by continuous antibacterial therapy. Sulfamethoxazole-trimethroprim, or nitrofurantoin can be used for a year as part of a therapeutic trial. An interval VCU is performed at 6 months and 1 year to reassess the presence of reflux. If the low-pressure reflux persists, then the Politano-Leadbetter procedure is indicated.

Incision and Surgical Approach. A transverse lower abdominal incision is made (see Fig. 33-1). The fascia is similarly incised. The rectus abdominus muscles are retracted from the midline in a lateral direction, exposing the bladder and perivesical tissues.

43-1. *The bladder is opened.* Two narrow pediatric Deaver retractors may be substituted for the self-retaining retractors. A third Deaver retrac-



43-1

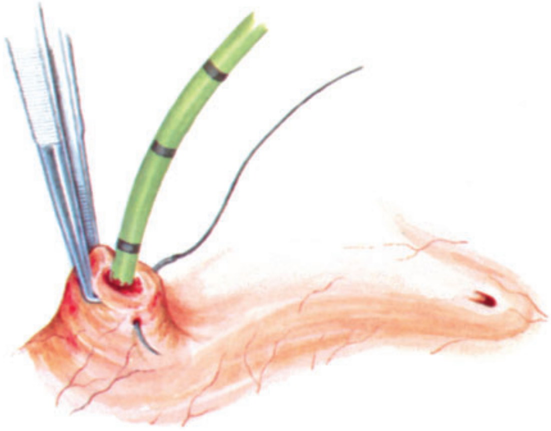
tor can be placed at the superior end of the bladder. The incompetent ureteral orifice is quite easily seen on the left side.

43-2. *A No. 5 feeding tube is inserted approximately 12–15 cm,* then a 3-0 silk stay suture is placed on one side of the ureteral orifice. Care is taken to include ureteral wall.

43-3. *The stay suture is tied around the tube* to allow traction on the orifice. A circumferential incision is made approximately 2–3 mm from the orifice.

43-4. *The ureter is freed from its supporting structures* for approximately 4–6 cm. Sharp and blunt dissection are used. A plastic iris-type scissor is useful during this maneuver. Occasionally, bleeding may be encountered. Hemostasis is important.

43-5. When the dissection is completed, *the ureter can be lifted with ease* through the opening in the bladder floor for at least 6–8 cm.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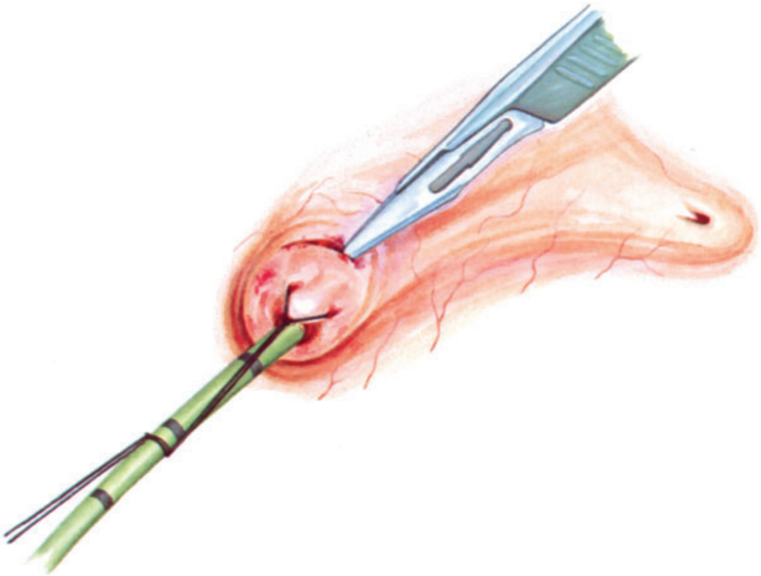
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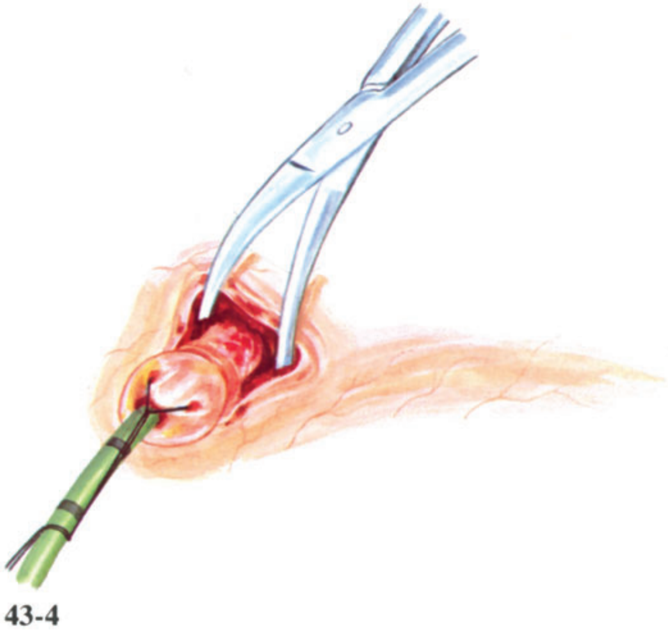
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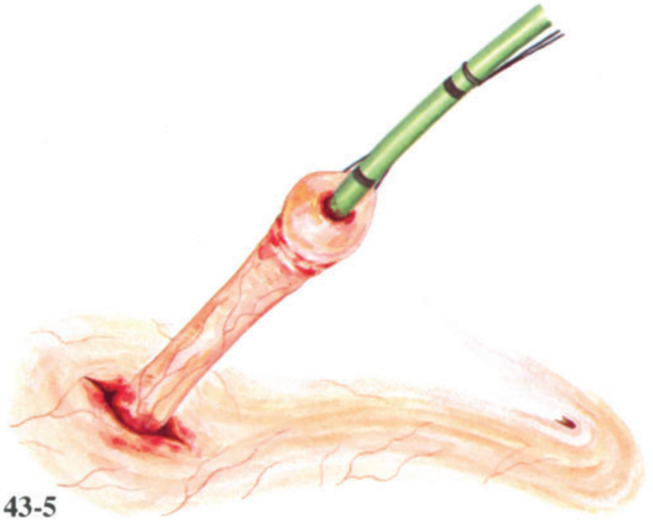
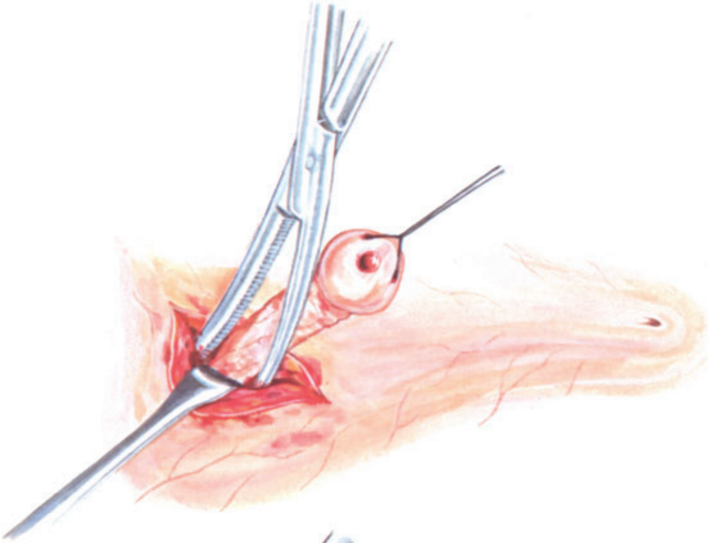

43-5

43-6. *Placement of the ureter into a new location* in the more superior and lateral aspect of the bladder wall is easily accomplished with the aid of a vein retractor to left mucosa and bladder musculature. By using the vein retractor, it is possible to visualize the posterior outside bladder wall where the new tunnel will be started. This maneuver will eliminate possible adhesions or inadvertent intraperitoneal dissection.

43-7. From the site of the old orifice *a right-angle clamp is passed behind the bladder in a superior lateral fashion* and pushed through the outer bladder wall to the mucosa, allowing an incision to be made through mucosa. The stay suture on the ureteral end is used to reroute the ureter through this new opening. The muscle layers at the site of the original ureteral orifice are reapproximated and sutured with 3-0 chromic catgut.

43-8. *The submucosal tunnel is created.* The stay suture is grasped and the ureter is gently pulled through the new submucosal tunnel. The 5 French feeding tube is inserted for 6–8 cm to rule out any obstruction, kinking, or twisting of the ureter.

43-9. *The ureteral orifice is sutured to the bladder mucosa* with interrupted 4-0 chromic catgut sutures. Inferior sutures are placed to include bladder muscle. The mucosal incision at the superior lateral end of the tun-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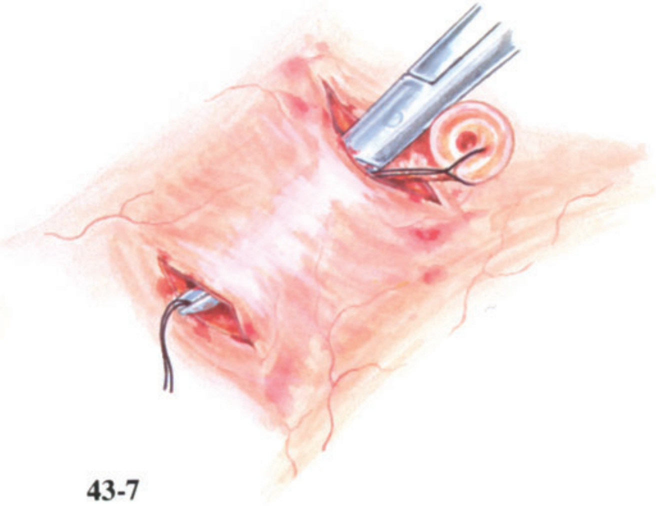
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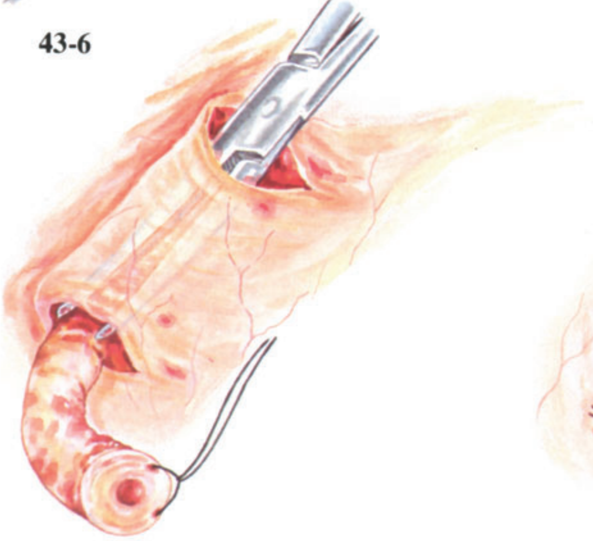
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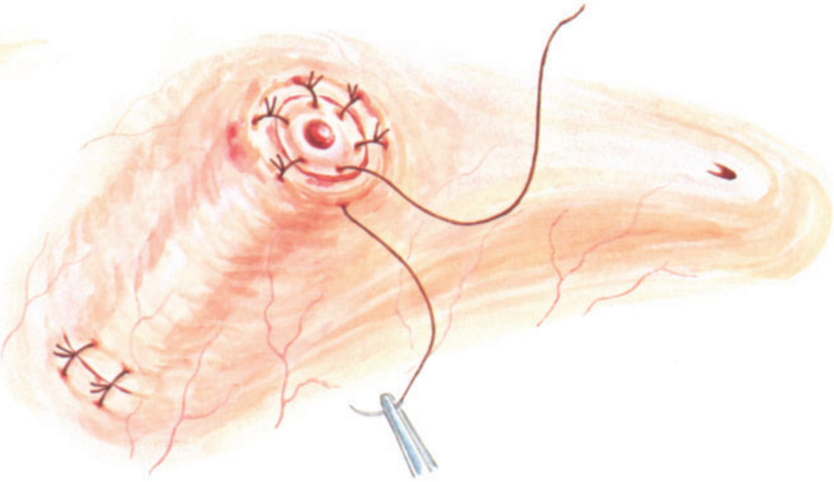

43-9

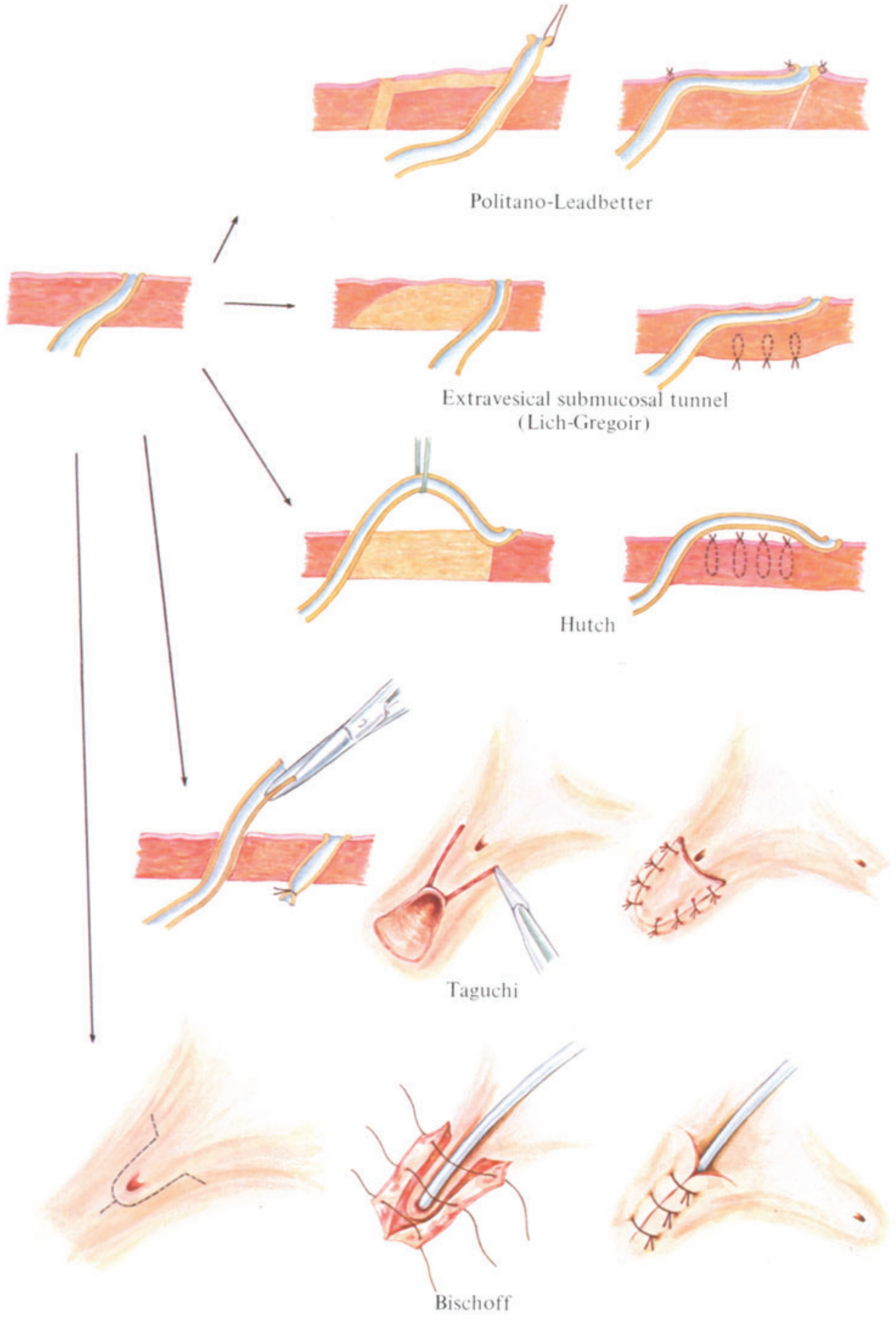
nel is sutured. A ureteral stent is left up the ureter and is brought out through the bladder through a separate anterior opening. The stent is removed after 3–4 days.

The identical surgical procedure is performed if the other orifice is also incompetent.

The bladder is closed in the usual manner. Two layers of chromic catgut are used (3-0). A suprapubic cystostomy tube is preferred over an indwelling urethral catheter. A Penrose drain is inserted paravesically and brought out through a separate skin incision.

44. Other Procedures

44-1. In addition to the Politano-Leadbetter[9] technique, *there are four alternative procedures:* the Lich-Gregoir[8,6] extravesical submuscular trough; the Hutch[7] technique; the Taguchi[10] method; and the Bischoff[2] technique.



44-1

45. Total Nephroureterectomy for a Ureteral Carcinoma

General Considerations. A ureteral tumor extending through ureteral muscle and producing nonfunction or poor function of a kidney on one side is generally treated by nephroureterectomy including a cuff of bladder wall. The diagnostic work-up of such a patient deserves mention.

Symptoms of pain, ureteral colic, or back pain (dull ache due to hydronephrosis and distention of the renal capsule) may bring the patient to a physician. The finding of gross or microscopic hematuria associated with pain should prompt the physician or urologist to obtain an intravenous pyelogram. If the appropriate kidney is not functioning, then cystoscopy and a bulb retrograde pyelographic study should be performed to assist in the diagnosis. Ureteral brushing of the tumor and appropriate examination of the cells may also confirm the diagnosis.

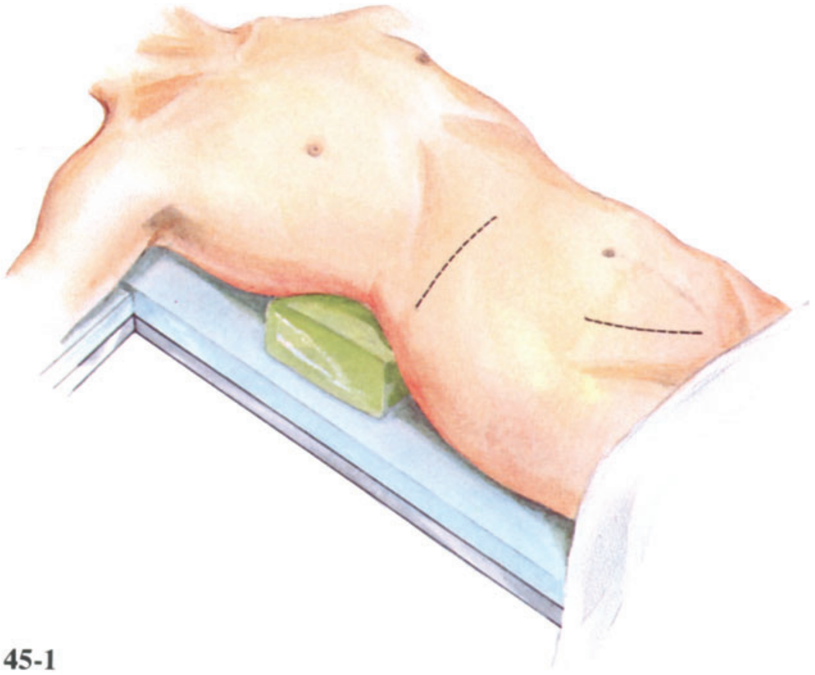
Finding a filling defect in the ureter at the site of obstruction after an intravenous pyelogram is often diagnostic. The differential diagnosis will include 1) ureteral tumor, 2) blood clot, or 3) nonopaque calculi. The uric acid level in the blood may assist in the diagnostic work-up of the patient.

In selected instances, performing antegrade pyelography has assisted significantly in the work-up. This has been useful in delineating the site of the lesion and the contour of the lesion from the superior side.

45-1. The patient lies supine, and *a sand bag is placed beneath the patient* on the appropriate side. The broken lines indicate the lines of incision. A transverse abdominal incision is first made.

45-2. *The external oblique muscle is severed;* the internal oblique is transected and separated. The lateral end of the rectus abdominis has been partially transected. The transversus abdominis is exposed in the middle of the field.

45-3. *The transversus abdominis muscle is separated,* and hemostasis is controlled by coagulation.



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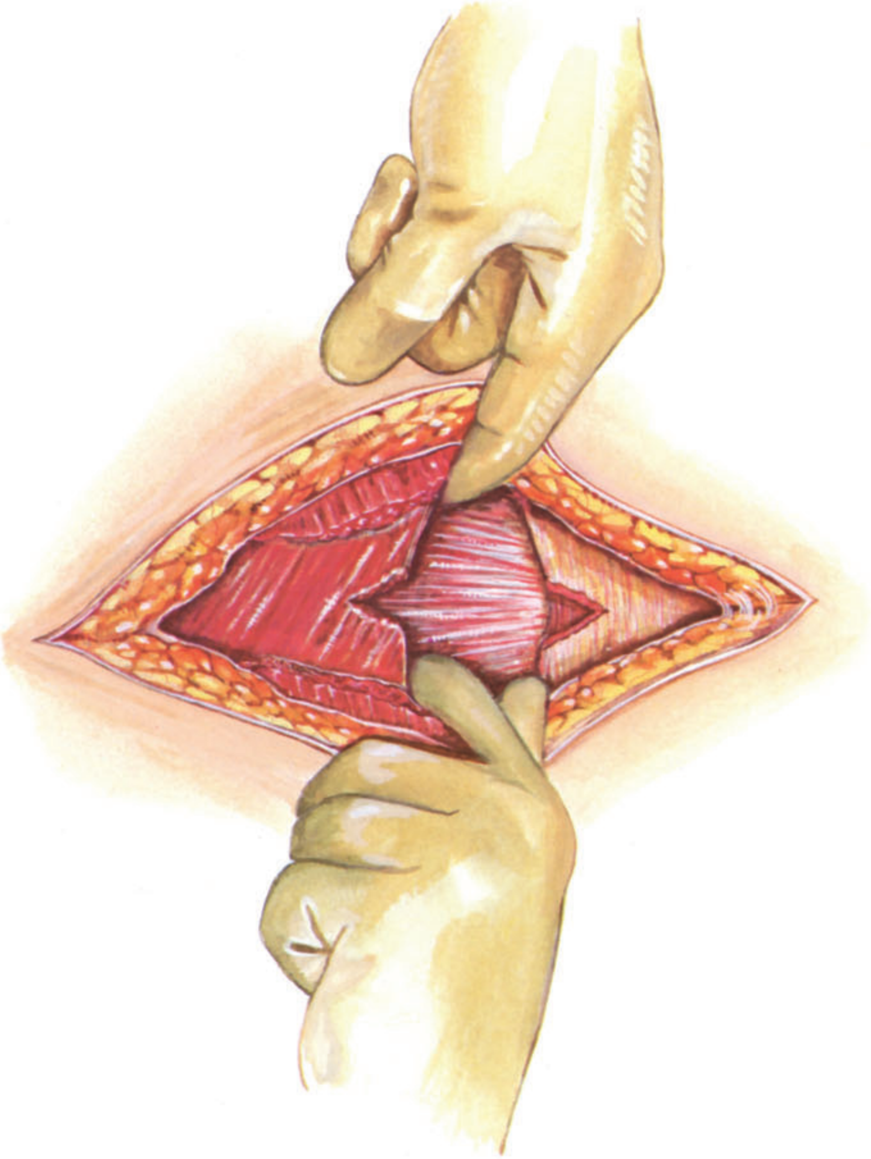

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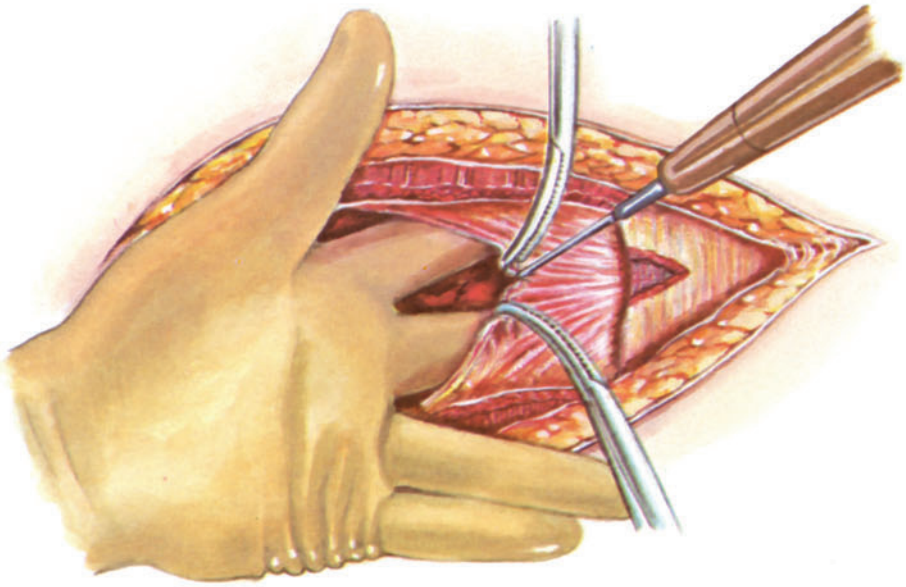
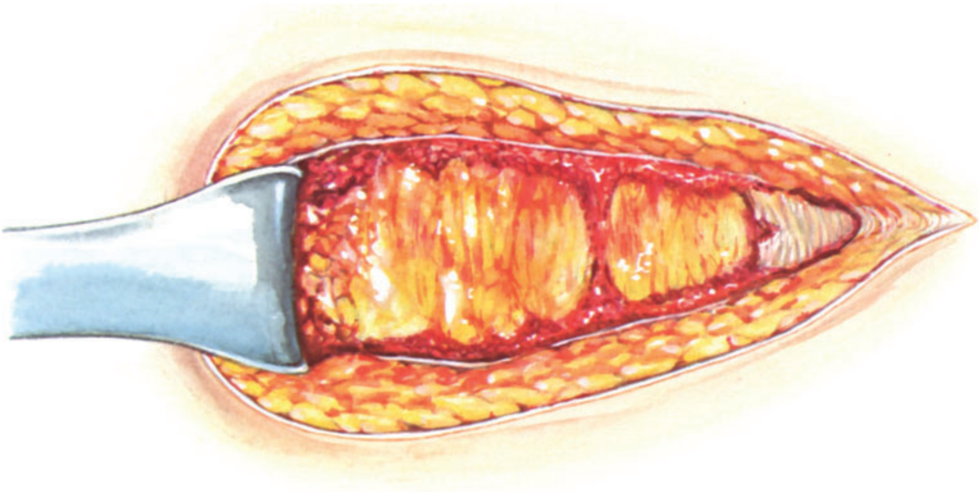


45-3

45-4. *Preperitoneal fat and extraperitoneal fat are exposed.*

45-5. *Gerota's fascia is incised,* exposing the kidney. The upper ureter is located and isolated by a Penrose drain.



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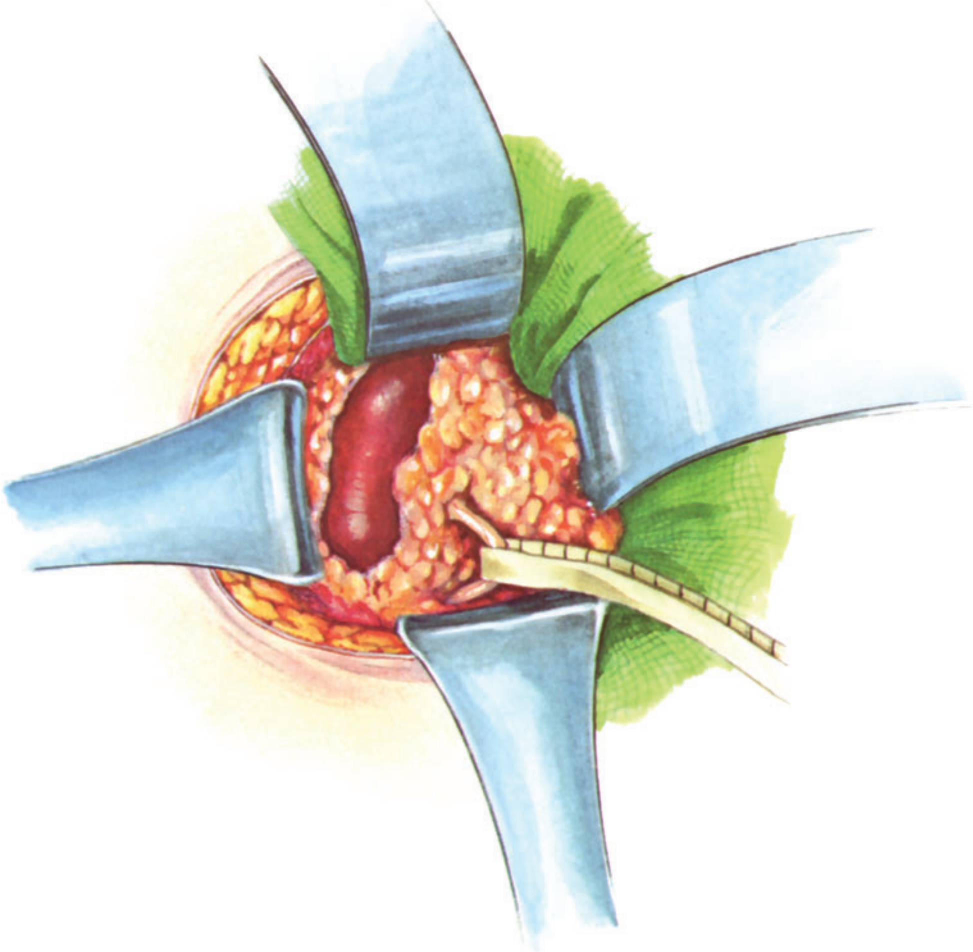
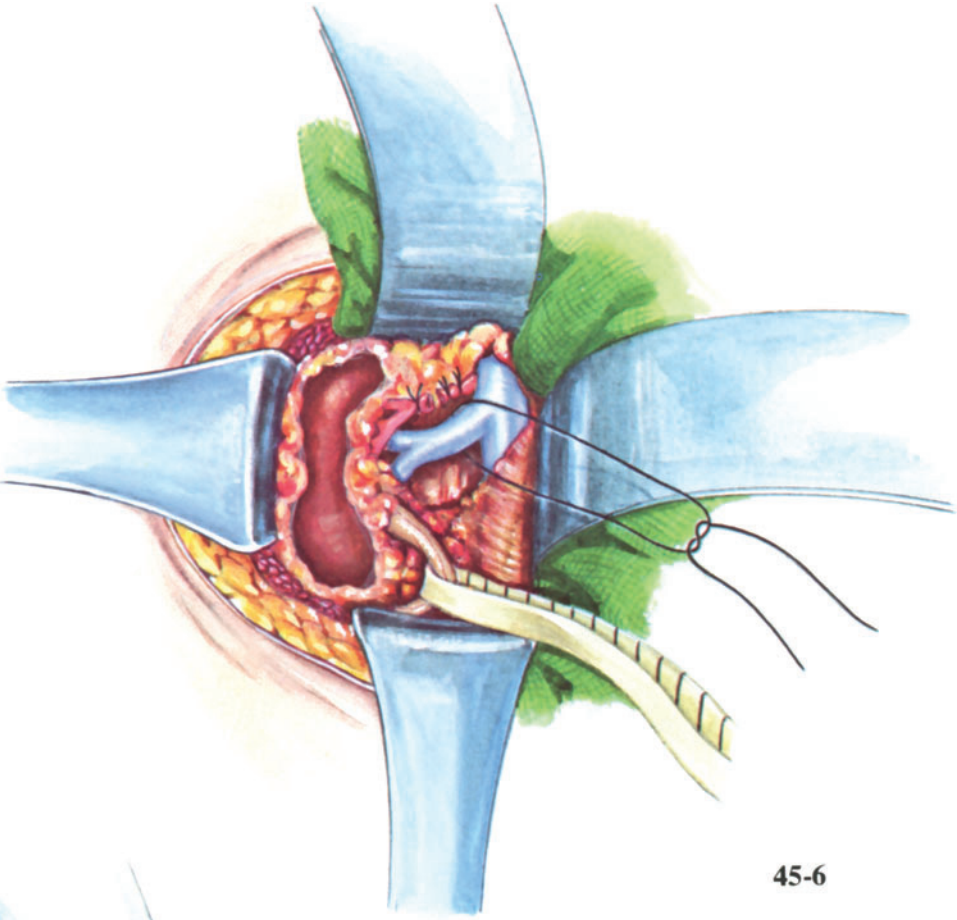


45-5

45-6. *The renal pedicle is exposed.* The renal artery is doubly ligated on the proximal side (1-0 silk) and severed. A tie has been placed around the renal vein prior to double ligation.

45-7. *The ischemic kidney is lifted out of its bed.* The ureter is still in continuity.



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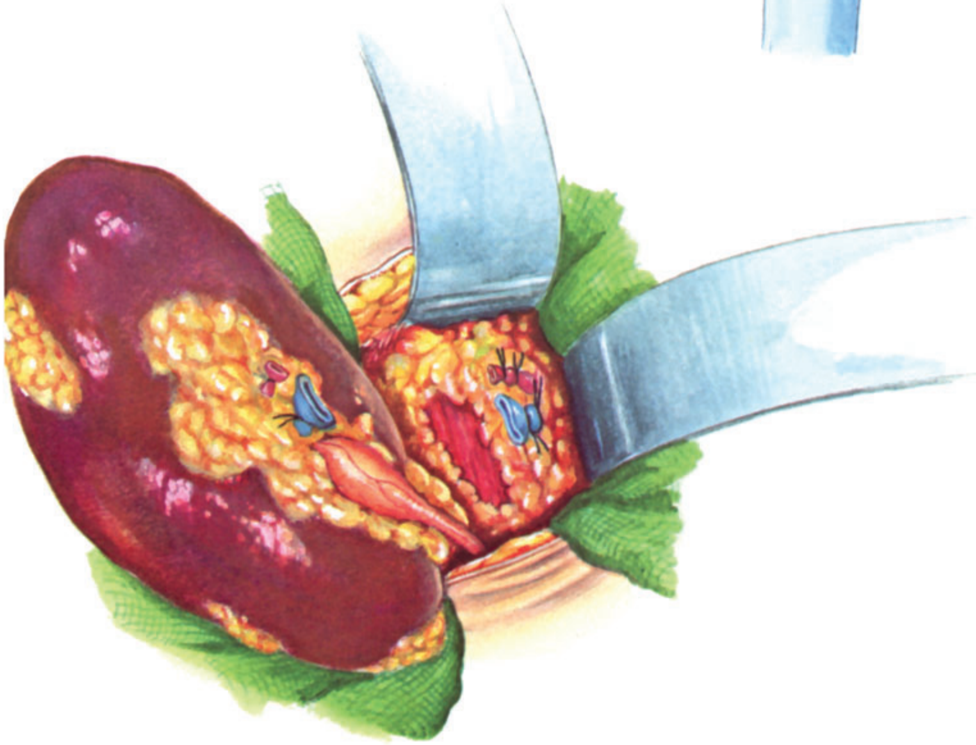
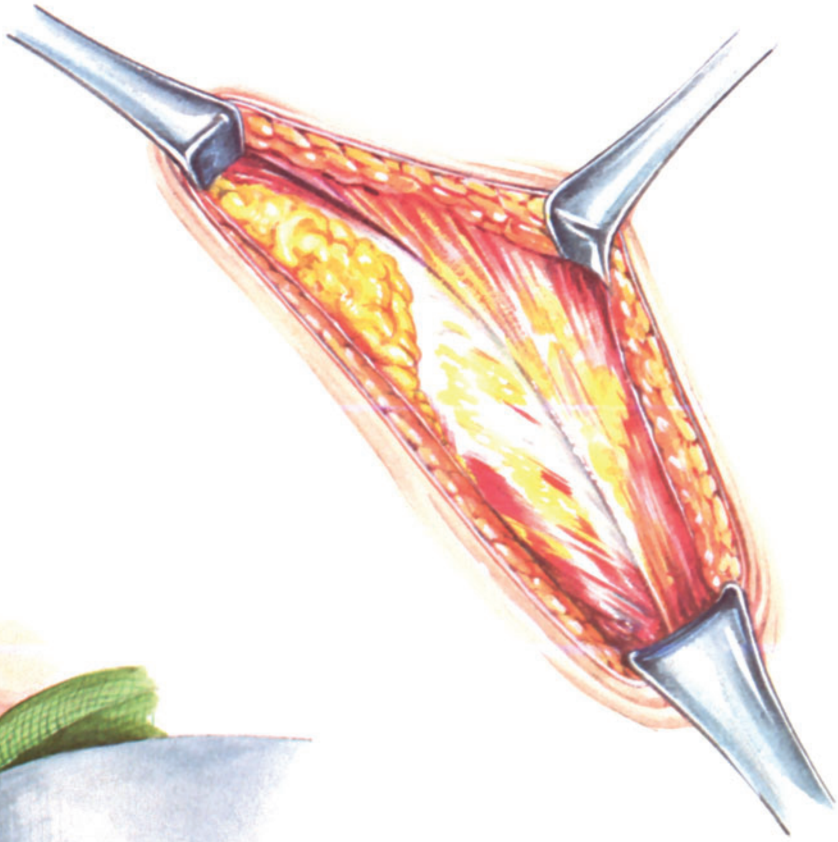


45-7

45-8. *The lower abdominal oblique incision is now initiated* (see Fig. 45-1).

45-9. After the muscle layers are incised and the peritoneum retracted medially, *the ureter and* the tumor are exposed. The bladder has been retracted medially.



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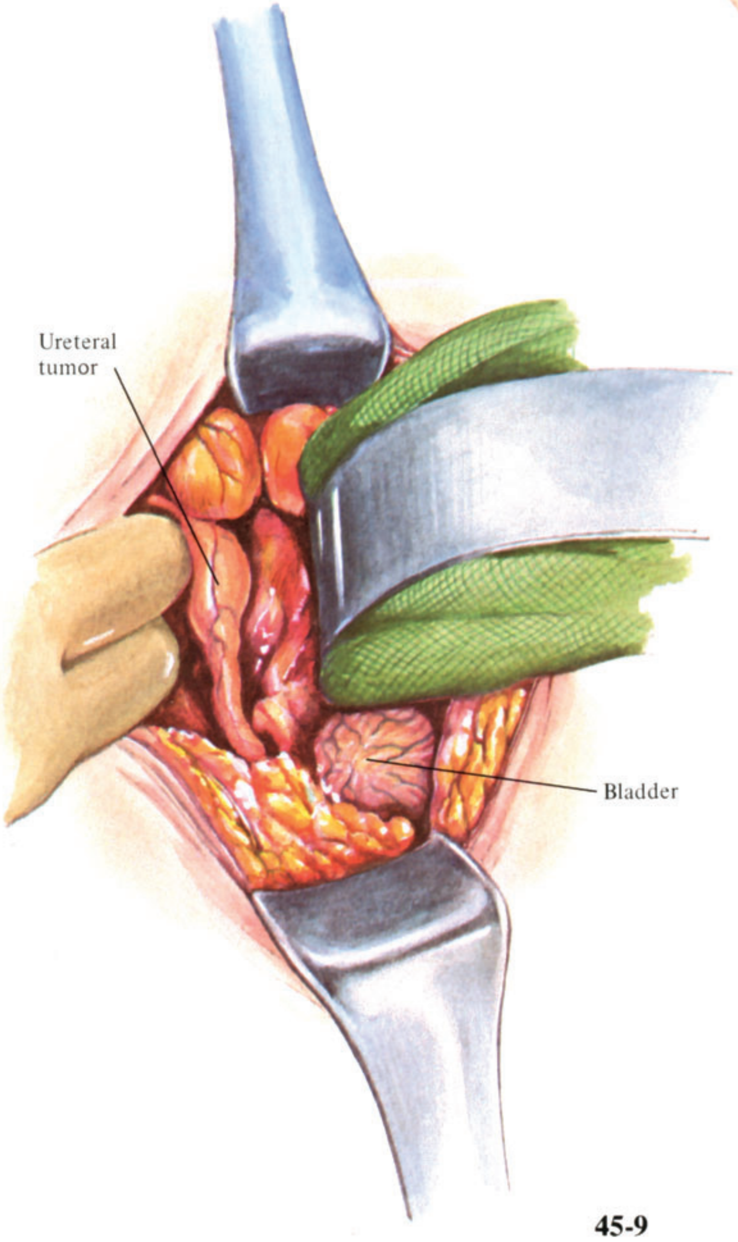

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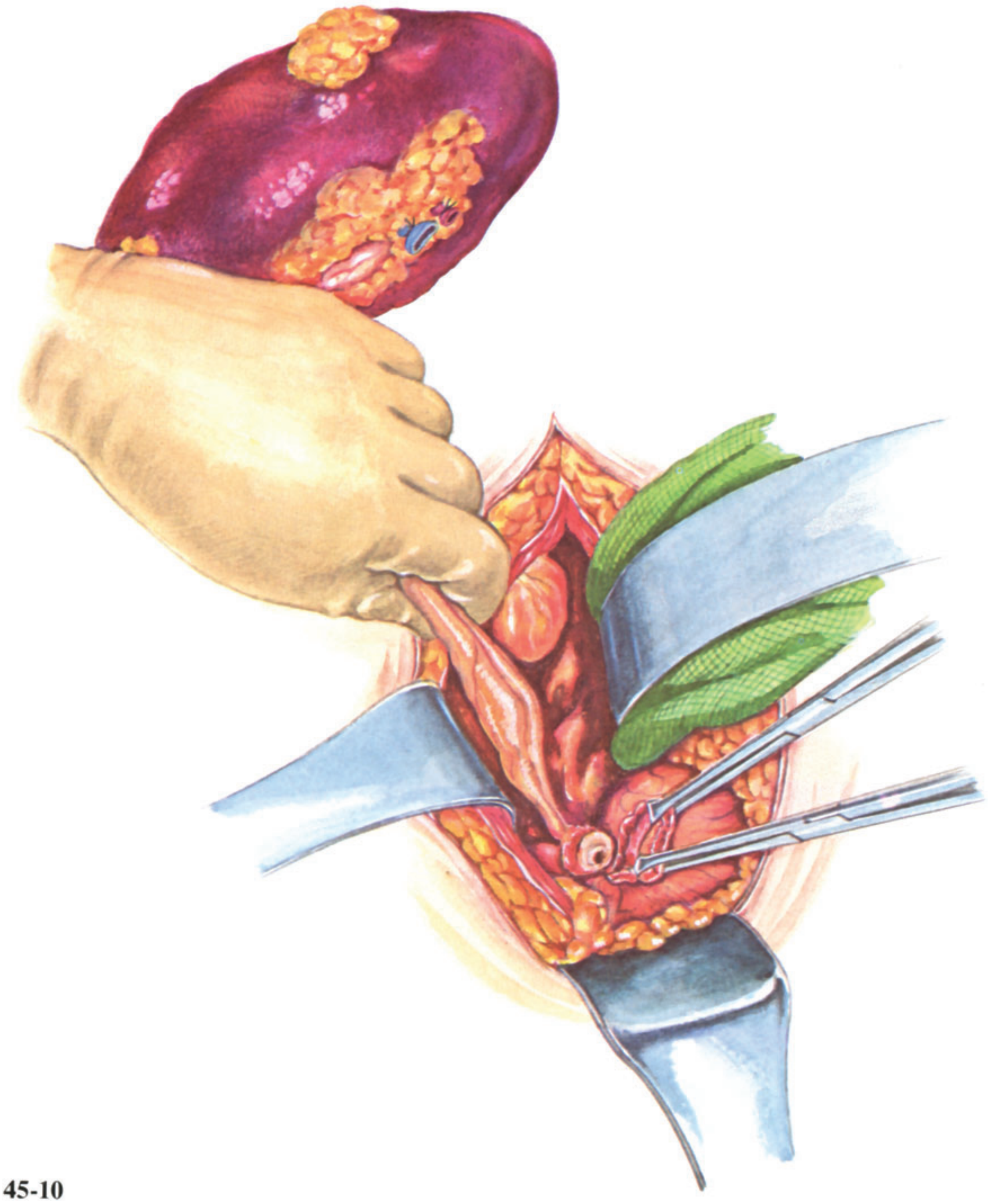

45-10

The extraperitoneal space between both incisions is developed by blunt dissection to allow passage of the kidney to the site of the inferior surgical field.

45-10. *A cuff of bladder including the distal ureter is removed* to complete the nephroureterectomy. The tumor is removed. The bladder opening is reapproximated in two layers (3-0 chromic catgut sutures).

Closure of both wounds can be performed simultaneously by members of the the surgical team. A Penrose drain is not necessary in the upper incision. A small Penrose drain can be led from the bladder area and maintained for 2–4 days.

The muscular layers are reapproximated.

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The Bladder

3

Surgical Anatomy

Structure and Location

The adult urinary bladder is located anteriorly in the pelvic cavity, behind the pubic bones; in infancy the bladder is located in the suprapubic region. The resting, contracted bladder is a thick-walled organ, having superior and inferior walls, a fundus, and an apex. The urachus or median umbilical ligament, a strong fibrous cord, attaches to the apex; the right and left ureters attach to the posterolateral angles. The urethra attaches to the fundus.

As the bladder fills and becomes distended and ovoid, the fundus remains fixed; the apex and superior wall rise from the pelvis toward the abdominal cavity; the lateral walls stretch from the superior and inferior walls.

Peritoneum covers the superior and posterior wall of the bladder (Fig. 1).

The fundus of the bladder is fixed by continuity with the urethra. The neck of the bladder is fixed by pubovesical and puboprostatic ligaments, which immobilize the bladder to the symphysis. The lateral umbilical ligaments, containing the atrophied supravesical portions of fetal umbilical arteries, also stabilize the bladder.

In the male, the posteroinferior aspect of the bladder is related to the rectum but is separated from it by seminal vesicles, ampullae of the vas deferens and the rectovesical fascia of Denonvilliers (Fig. 2).

In the female, the posteroinferior aspect of the bladder rests against the upper part of the vagina and uterine cervix. The uterus extends and arches behind the posterosuperior aspect of the bladder but is separated by the pouch of covering peritoneum, forming the vesicouterine excavation.

The prevesical or space of Retzius is a division of the extraperitoneal space that extends from the pelvic floor to the umbilicus, bounded anteriorly by the posterior sheath of the rectus muscle and the posterior surface of the pubic rami. Urinary extravasation caused by extraperitoneal rupture of the bladder or by prostatic capsule perforations may extend rapidly into this space.

The bladder wall consists of several muscle layers. A layer of transitional cell epithelium covers the inner surface. The submucosal layer forms

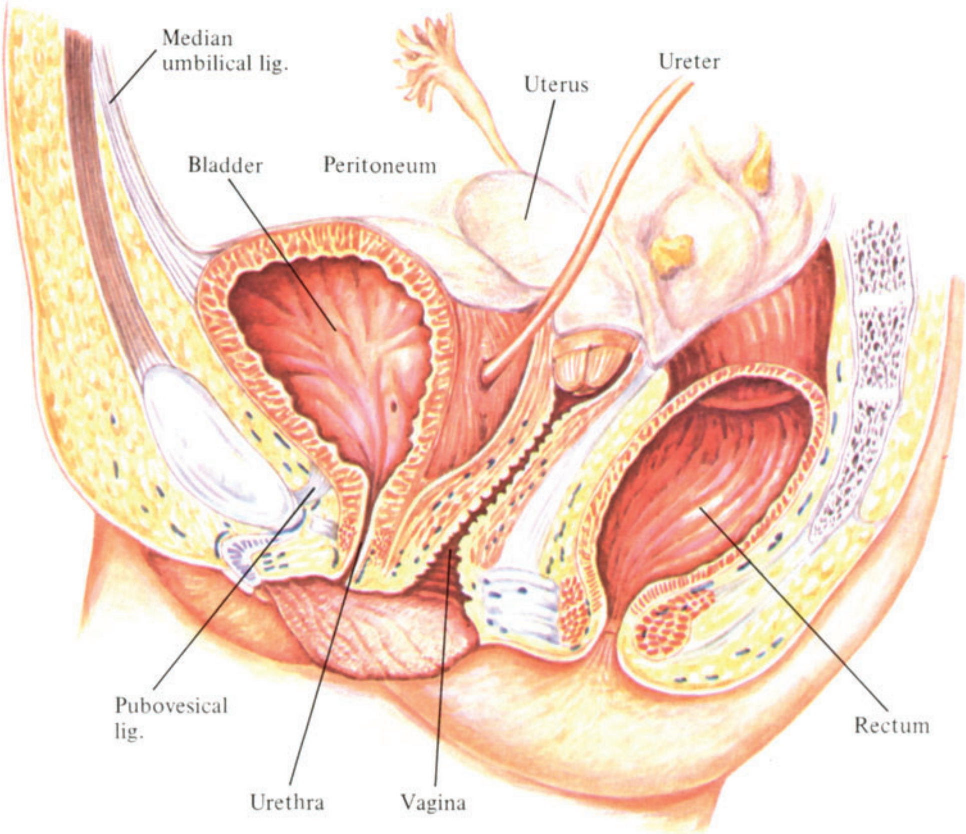


FIG. 1. Midsagittal view showing structure and location of urinary bladder.

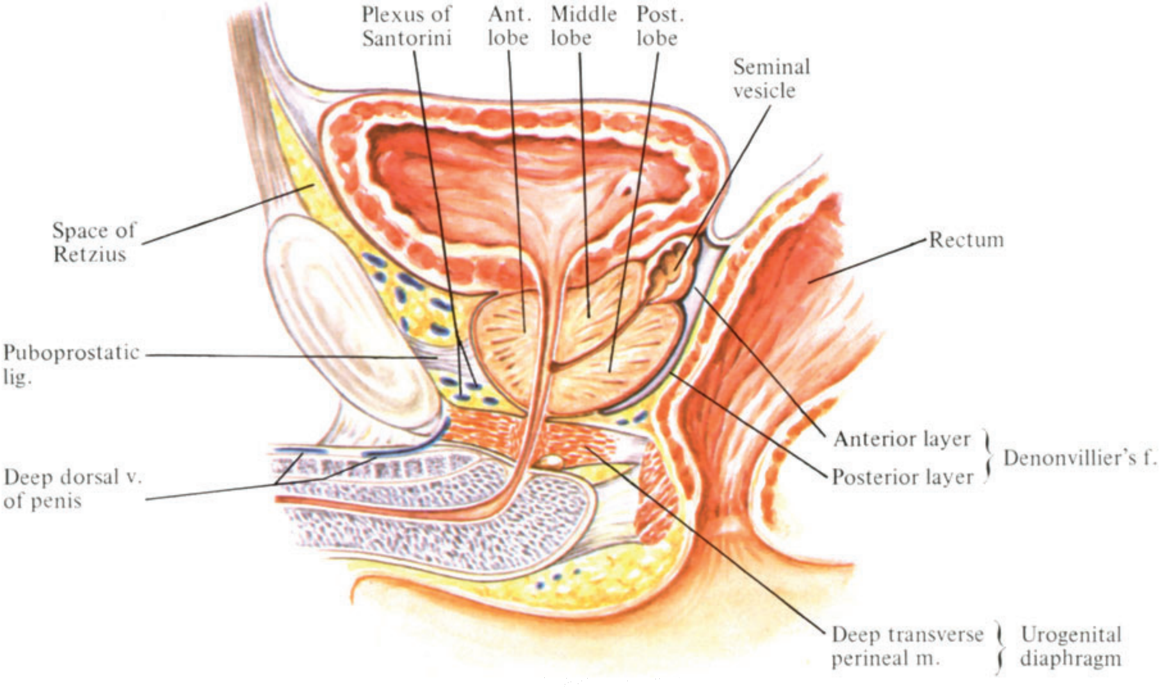


FIG. 2. Midsagittal view at prostate, showing fascial relationships.

a loose connection between the muscle layer and the epithelium. The muscle layer consists of numerous bundles of nonstriated muscle traveling in different directions both obliquely and circularly around the bladder and forming a thick, elastic muscular wall. At the bladder neck these muscle bundles merge to form a ring called the internal vesical sphincter. A fascial layer loosely coats the muscle layers, except on the superior and upper part of the posterior surface, where it becomes very thin and is closely covered by a serous layer of peritoneum.

The appearance of the bladder interior varies, depending on the degree of bladder wall tension. When empty, the greater part of the bladder mucosa is thrown into folds and presents a wrinkled appearance. As the bladder distends, the mucosa becomes smoother, with fewer folds.

The trigone is a smooth-surfaced triangular area lying between the ureteral orifices at its basal angles and the internal urethral orifice at its apex (Fig. 3).

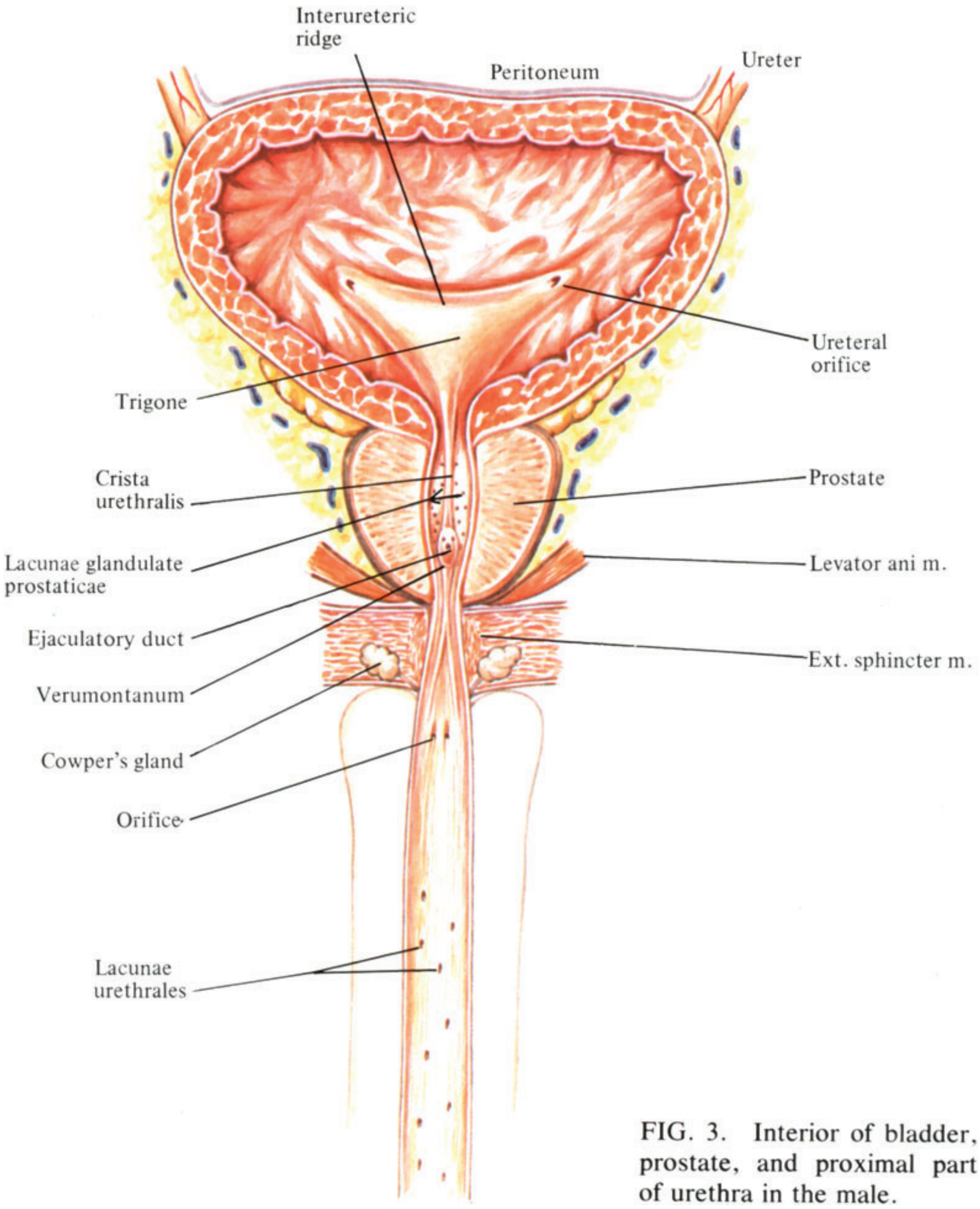


FIG. 3. Interior of bladder, prostate, and proximal part of urethra in the male.

The interureteric ridge is a well-defined elevation between the ureteral orifices, which is raised by an underlying ridge of muscle.

Vascular Supply

The arterial supply to the bladder derives mainly from the internal iliac artery and is composed of superior, middle and inferior vesical arteries (Fig. 4). The superior vesical artery, which is the unobliterated part of the umbilical artery, supplies the superior and lateral walls of the bladder. The superior vesical artery reaches the bladder under the lateral reflection of pelvic peritoneum. The middle vesical artery is inconstant and may arise from the superior vesical artery or the internal iliac artery; often, it may be absent. The inferior vesical artery is derived from the internal iliac artery and is distributed between the fundus of the bladder, the seminal vesicles, and the prostate. Additional smaller arteries are derived from the middle hemorrhoidal and obturator arteries and, in the female, from the vaginal and uterine arteries.

The veins of the bladder anastomose freely to form perivesical plexuses, which are dense around the fundus of the bladder and drain into the internal iliac veins. In the male, the larger veins lie in the groove between the bladder and the prostate and form the vesicoprostatic plexus.

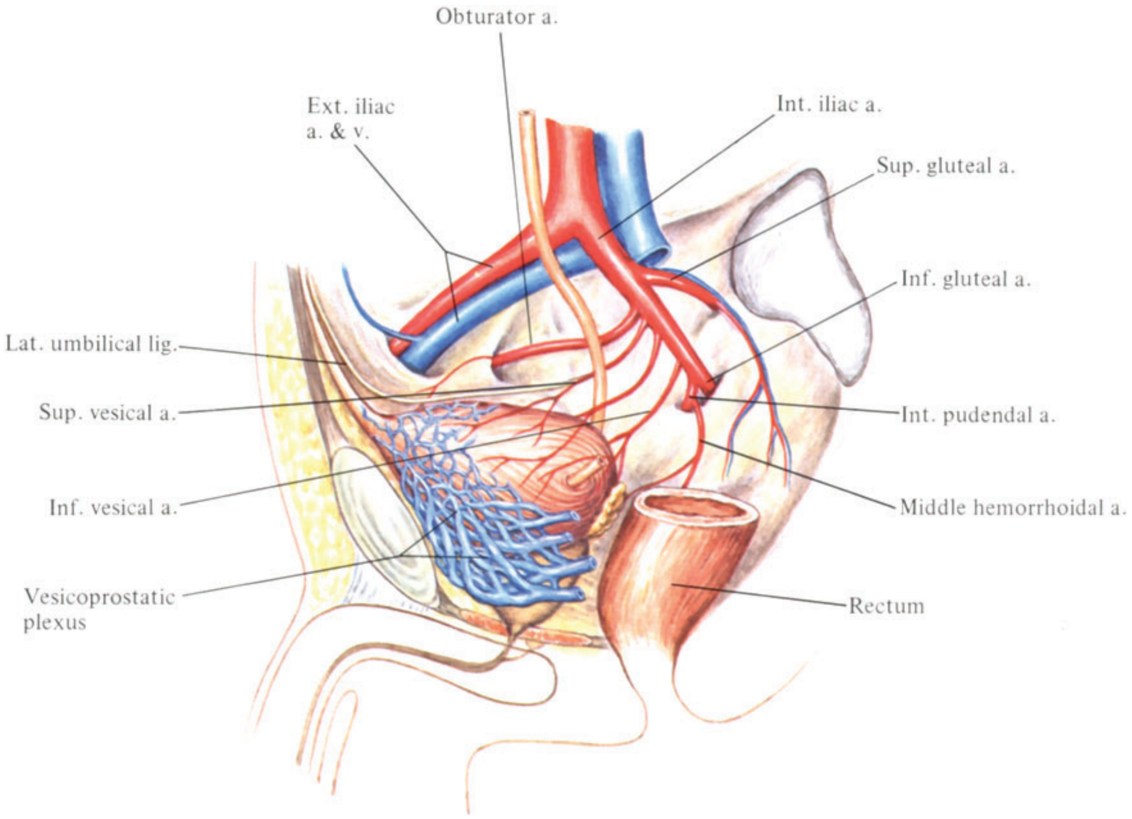


FIG. 4. Arterial and venous supply to the bladder (sagittal view).

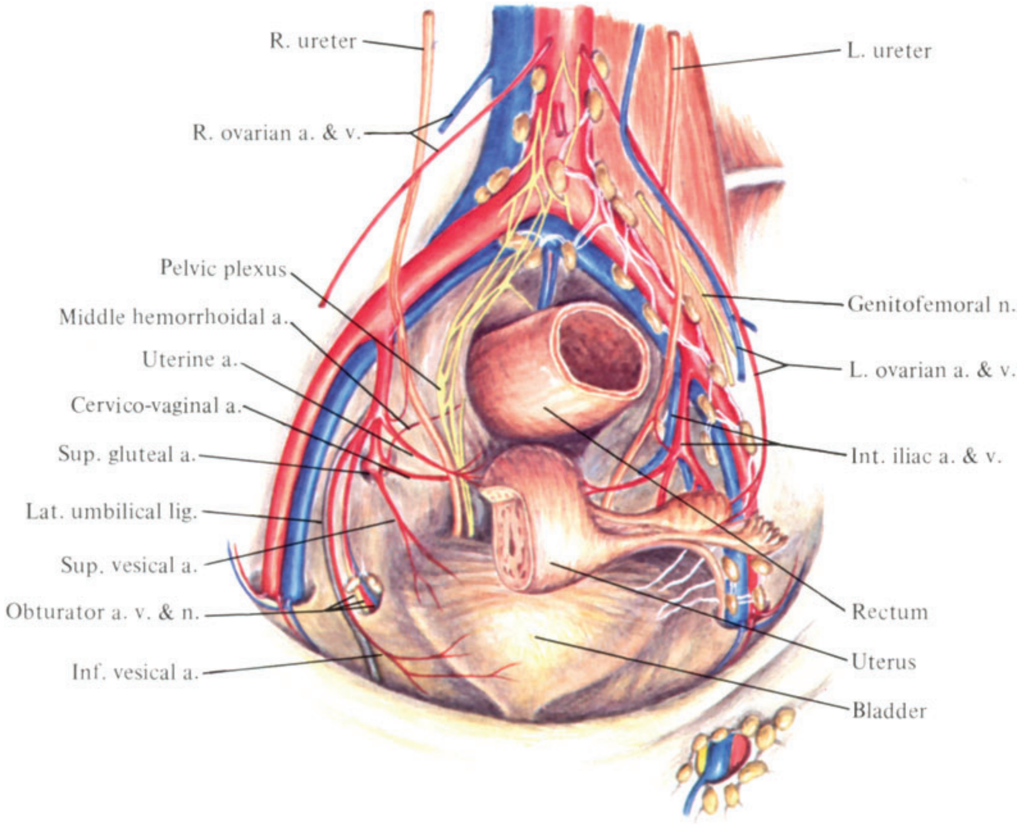


FIG. 5. Pelvic portion of female ureter.

The lymphatics of the bladder (Fig. 5) begin in the submucosal layer of the bladder wall, collect in larger channels in the deep layer of muscle wall, follow the veins, and drain into lymph nodes along the internal and external iliac vessels.

Nerve Supply

The nerve supply to the bladder accompanies the supplying arteries and consists of nerves from both divisions of the autonomic system. Somatic nerves which control the sphincter are also present.

Sympathetic fibers are distributed to the bladder from the 11th thoracic to the second lumbar segments via the hypogastric and pelvic plexus. These nerves are stimulated during filling of the bladder and act to inhibit detrusor muscle tone; they also increase tension in the internal sphincter.

Parasympathetic fibers to the bladder arise from the pelvic splanchnic nerves, which are derived from the anterior primary divisions of the second to fourth sacral segments. These fibers stimulate "emptying" of the bladder and come into play during micturition by stimulating detrusor muscle contraction, elevating the trigone and relaxing the internal sphincter. This event is accompanied by voluntary relaxation of the external sphincter by means of cerebral control via the pudendal nerve. The pudendal nerve arises from primary divisions of the third and fourth sacral segments and passes through the fatty tissue of the ischiorectal fossa (Fig. 6).

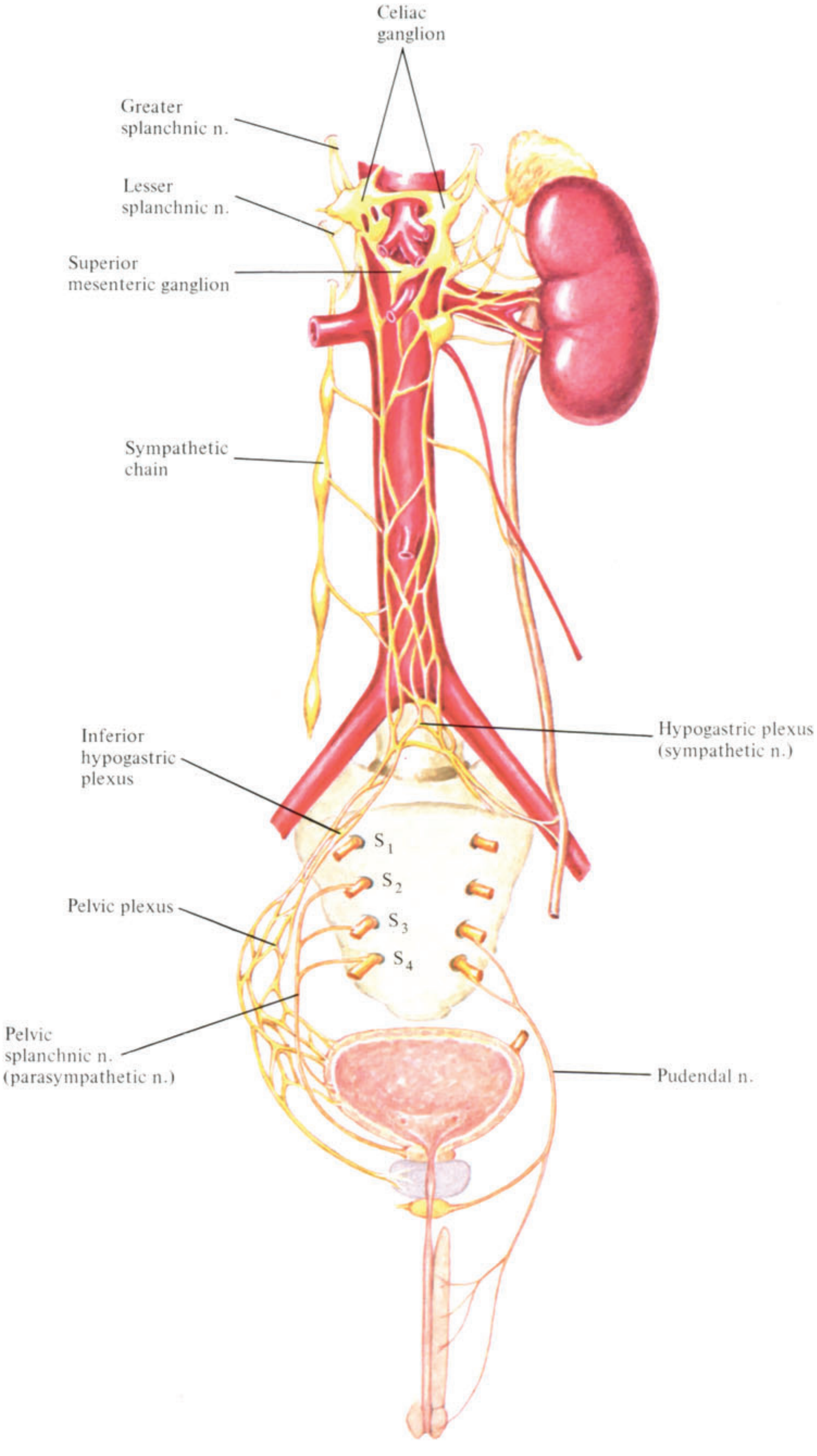

Celiac ganglion
Greater splanchnic n.
Lesser splanchnic n.
Superior mesenteric ganglion
Sympathetic chain
Inferior hypogastric plexus
Hypogastric plexus (sympathetic n.)
S_1
S_2
S_3
S_4
Pelvic plexus
Pelvic splanchnic n. (parasympathetic n.)
Pudendal n.

FIG. 6. Autonomic and somatic nerve supply to the male urogenital system.

Operative Techniques

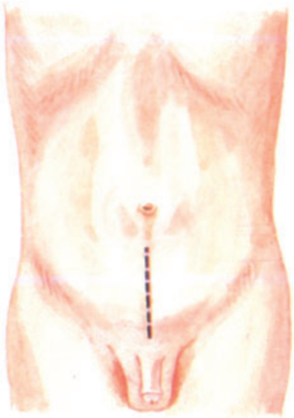
46. Suprapubic Cystostomy

This procedure is facilitated by filling the bladder prior to surgery (approximately 200 ml in adult).

46-1. *A vertical midline incision* is made, extending 5–8 cm inferior to the umbilicus to the symphysis. In the female patient we favor a transverse skin incision following skin lines.

46-2. The incision is carried through the fascia. *The rectus abdominis muscles are separated bluntly by the index finger.*

46-3. *A self-retaining retractor is inserted.* The perivesical space is freed by blunt dissection, and the anterior bladder surface is exposed.



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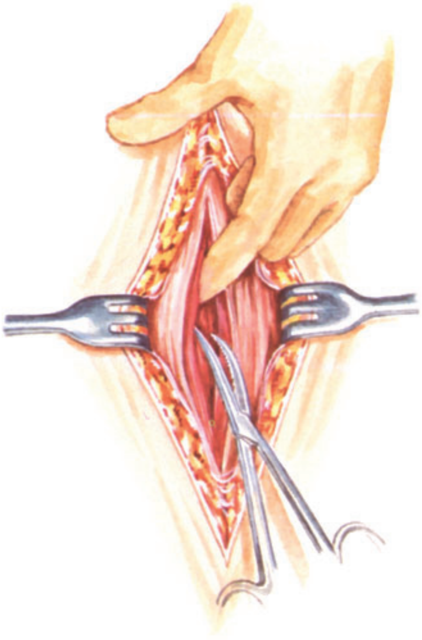

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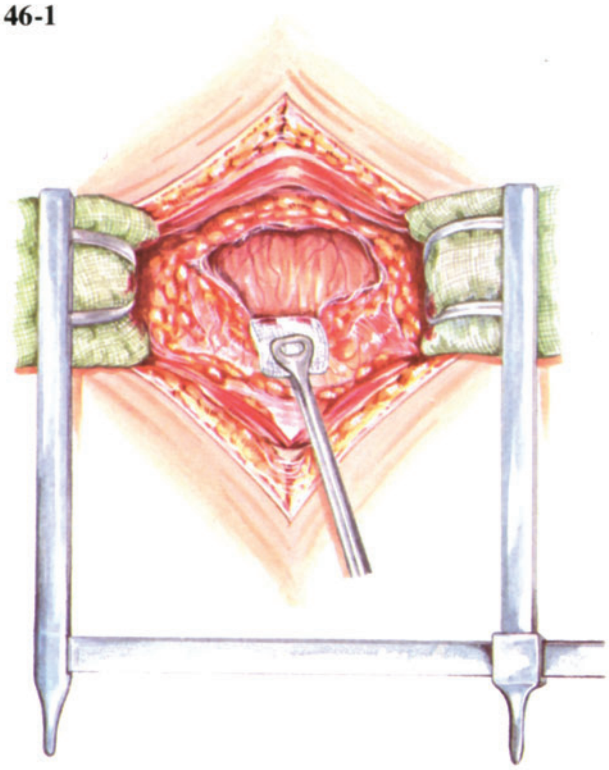


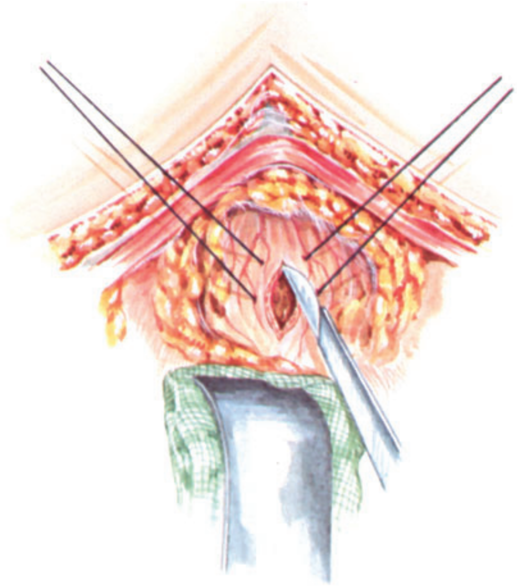
46-3

46-4. *Stay sutures are inserted, and the bladder wall is incised.* The bladder can now be emptied by suction.

46-5. A mushroom tip catheter is introduced into the incised anterior bladder (26 French in an adult; 18 French in a child). Tension is maintained on the stay sutures while the catheter is being introduced. A straight forceps facilitates this maneuver.

46-6. After the catheter has been introduced, the stay sutures are removed, and *the catheter is secured to the outer surface of the bladder.*

46-7. *With the catheter and a Penrose drain in place,* closure of the wound is effected in the usual fashion.



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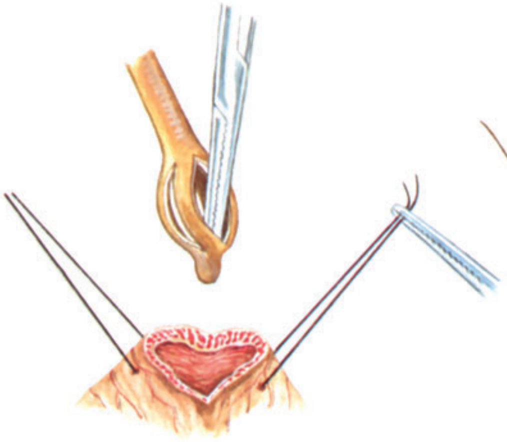

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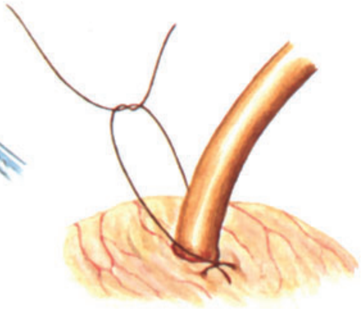

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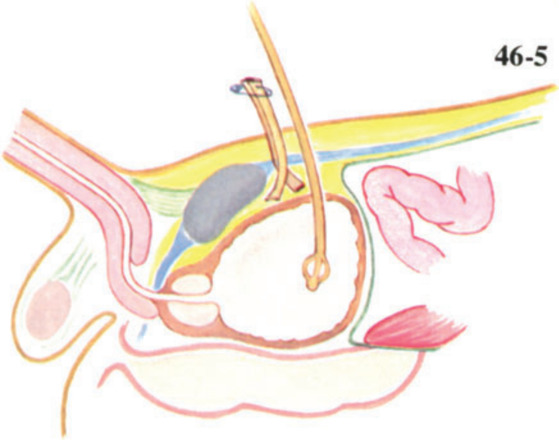


46-7

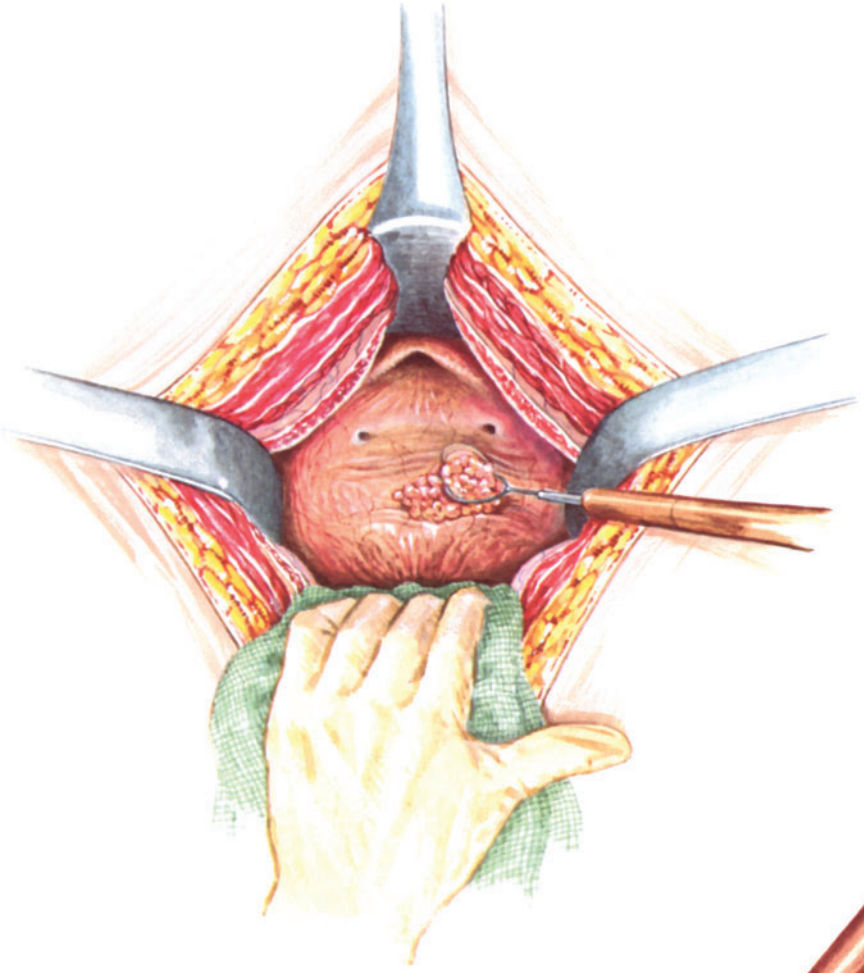
47. Open Resection of Tumor

The following procedure is used when the tumor has not invaded deep muscle and serosa and is on the posterior and/or lateral bladder wall. The extent of the tumor has been assessed by previous cystoscopy. The approach to the bladder is the same as that in Figures 46-1 to 46-4.

47-1. *The broad tumor is resected by means of electrocautery* (cutting current). The tumor area is resected, avoiding complete penetration of the wall.

47-2. A smaller electrocautery tip is useful for hemostasis in the deeper margins of the bladder wall.

Closure is performed in the usual manner. A Penrose drain is introduced into the paravesical space. Suprapubic cystostomy (see Fig. 46-5) and urethral indwelling catheterization can both be used to ensure hemostasis.



47-1

47-2

48. Open Repair of Bladder Neck Contracture

To approach the surgical field of the bladder, see Figures 46-1 to 46-4.

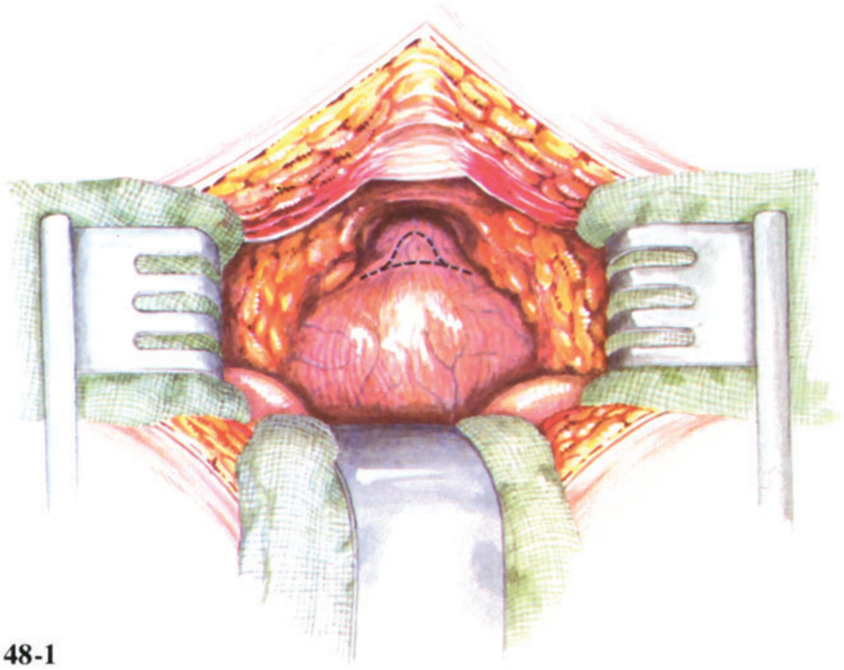
48-1. In our experience, the anatomic relationships of the bladder flap can be lost; therefore it is advised that the area of incision be outlined with stay sutures and/or an electrocoagulating tip. *The line of incision and the final placement of the anterior bladder flap are indicated by the broken line near the center* of the illustration. Note that the bladder is filled prior to the operation.

48-2. The bladder incision is made transversely and follows the previously marked area. The bladder fluid is suctioned out. *Wedge resection of the posterior bladder neck* is made from 5 to 7 o'clock.

48-3. *Hemostatic sutures lateral to the edge of the posterior neck resection* (2-0 chromic catgut) *are helpful.*

48-4. *Bladder widening flap placement and closure are completed.* The bladder neck contracture has been relieved.

Before abdominal wall closure an indwelling catheter is introduced, and a Penrose drain is positioned lateral to the site of bladder incision.



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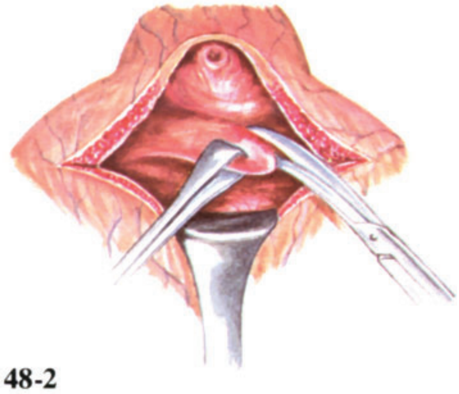

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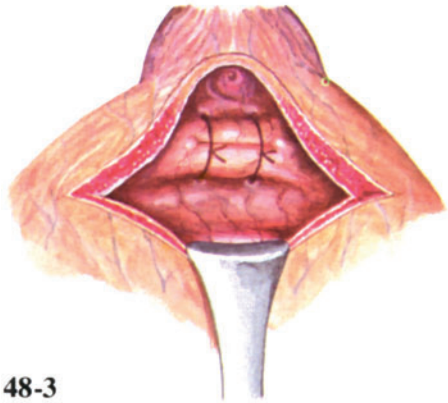

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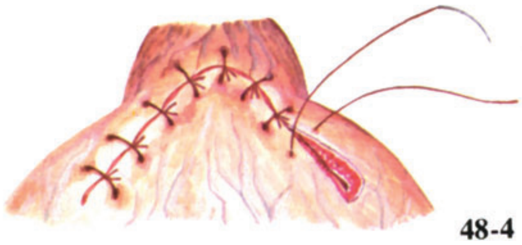


48-4

49. Boari-Ockerblad-Bischoff Bladder Flap for Ureteral Substitution[1,5]

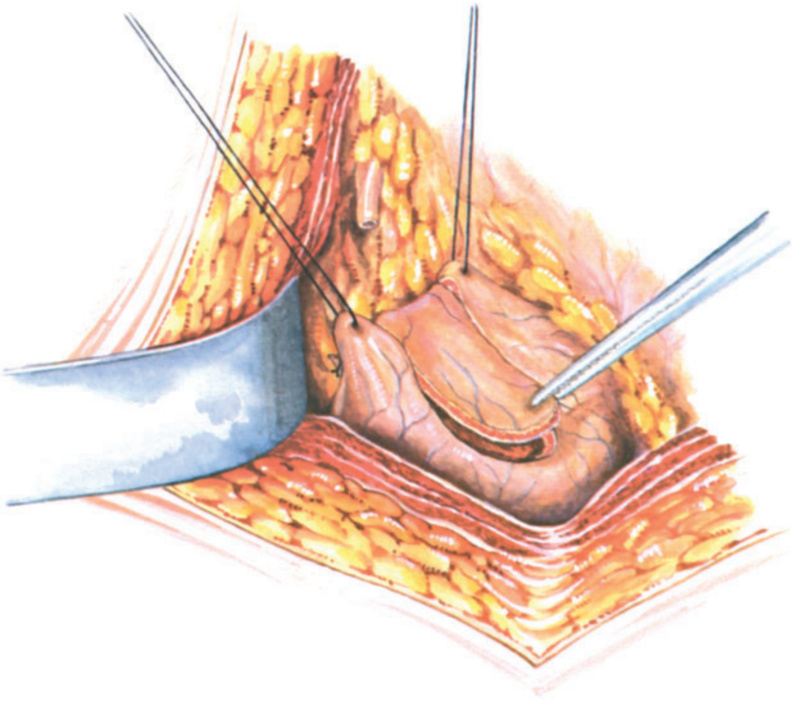
Indications for Procedure. When disease involving the lower third of the ureter has occurred, resulting in severe stricture formation or a megaureter, a Boari-plasty should be considered. In many areas of the world tuberculosis can cause fibrosis with beading to a long segment of the lower ureter. In cadaver kidney transplantation procedures, kidney rejection, including fibrosis to the lower ureter may also occur.

In any of the conditions cited, it is sometimes possible to hitch the superior-posterior portion of the bladder to the healthy ureter. If this is not possible then a Boari-plasty is an excellent alternative.

Other alternatives may be used in selected instances, when the lower ureter on the appropriate side is not coursing through an inflammatory or infected bed of tissue. Renal autotransplantation is a possible solution in a few instances. Another possible alternative is transureteroureterostomy, as described in Figures 36-1 and 36-2 in the chapter on the ureter.

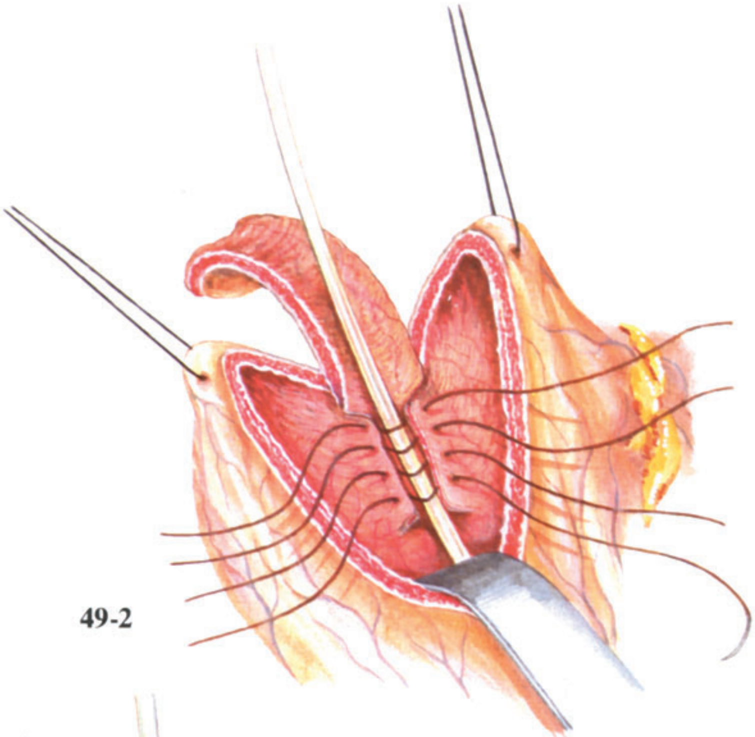
A vertical midline incision extending from the symphysis to the umbilicus is made. The anterior and lateral bladder surfaces are exposed. The ureter, which is diseased in its lower third, is transected and ligated, freeing the normal midureter.

49-1. *Stay sutures are placed on each side at the base of the selected bladder flap site.* The bladder flap is constructed; the extent of the flap is predicated on the length of the ureteral defect. The base of the flap curves posteriorly to the back bladder wall.



49-1

49-2. *The Bischoff antireflux Boari-plasty.* Note that a flap of bladder mucosa—tongue-shaped—must be removed to expose a muscular trough for the antireflux procedure. The parallel incisions are approximately 8 mm apart and extend from the base of the Boari flap to a point 2 cm proximal to the bladder neck. The trough extends through one-half the bladder musculature. Care is taken to protect the opposite ureteral orifice. An 8 or 10 French stent is used. The lateral bladder edges are undermined to allow reapproximation of the antireflux tunnel. This tunnel is sutured; the most distal sutures are placed first, moving proximally. Each suture includes bladder mucosa and muscle. The most proximal suture (the last) is placed from outside the bladder to its interior and made ready for tying outside the bladder.



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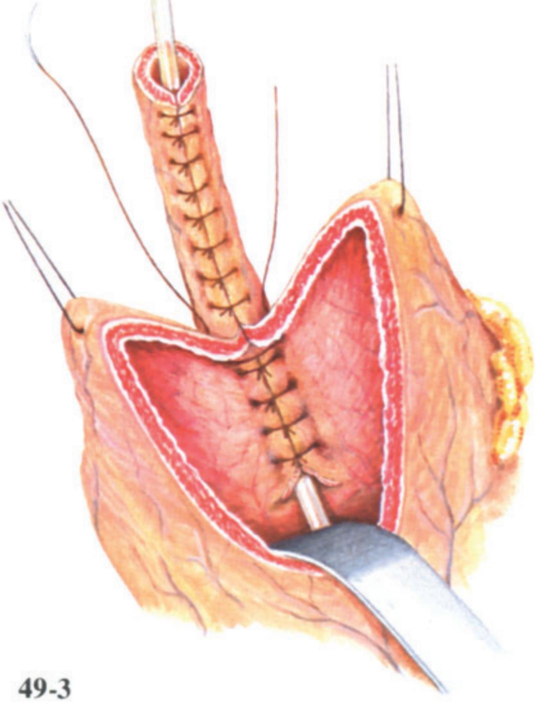

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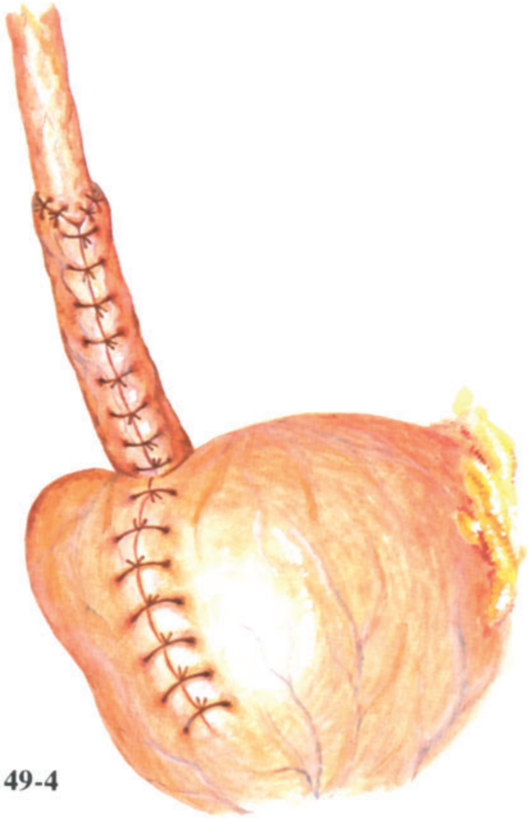


49-4

49-3. *The bladder flap* (Boari flap) *is tubularized* with 3-0 chromic catgut. The antireflux sutures are tied, moving superiorly or proximally. The most proximal antireflux suture is tied last, outside the bladder.

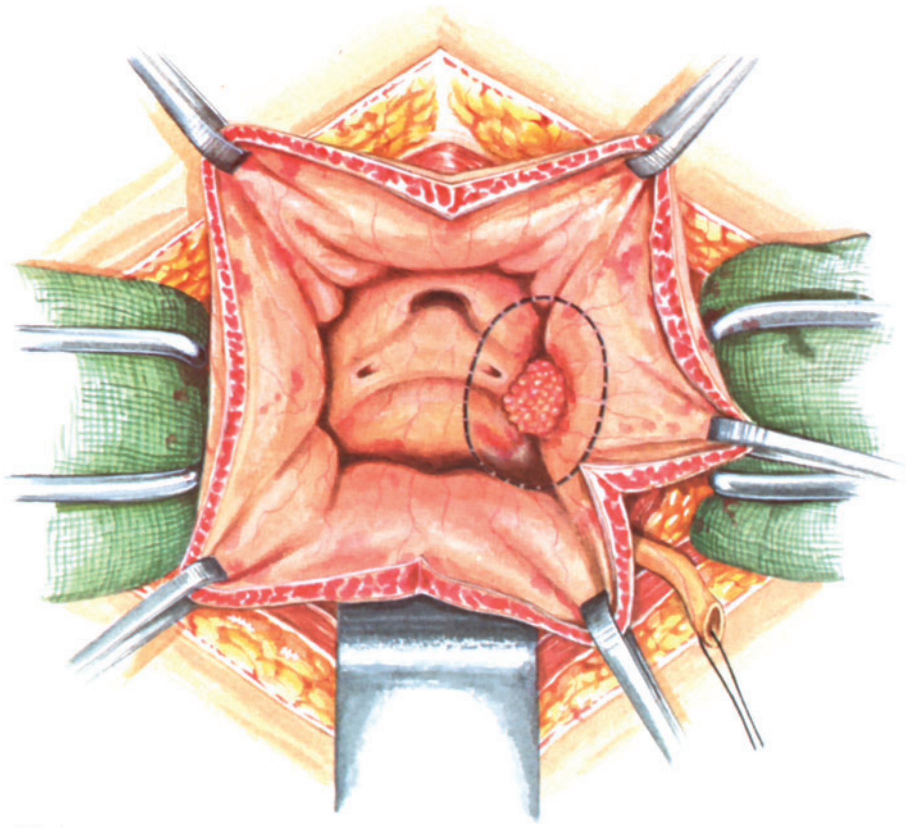
49-4. *The bladder is closed in two layers* with continuous and interrupted sutures (3-0 chromic catgut). The final step involves an end-to-end oblique anastomosis between the bladder flap and the ureter.

50. Partial (Segmental) Cystectomy

Careful patient selection for this procedure is important. Elderly patients with infiltrative bladder carcinoma located in the dome and/or lateral bladder wall are candidates. This procedure can be performed in poor-risk patients who probably cannot withstand radical cystectomy and urinary conduit diversion. A segment of the bladder floor can be excised in continuity with the lateral aspect of the organ. Ureteral reimplantation is necessary in this instance.

An oblique lower abdominal incision is made to allow access to the lower ureter and appropriate bladder hemisphere (Fig. 33-1).

50-1. *The bladder is opened widely* via an anterior midline incision. The bladder field is extended and maintained by the use of Allis clamps. The bladder tumor is seen on the right lateral wall. Because of tumor proximity to the right ureteral orifice, the ureter is transected and the distal tip ligated. A stay suture marks the proximal free end. An incision is made to approach the circumferential area which must be excised (dotted line). This includes removal of the right ureteral orifice, adjacent trigone, and ureteral stump.



50-1

50-2. *The line of excision is reapproximated and sutured in two layers.* The ureter is reimplanted on the posterior bladder.

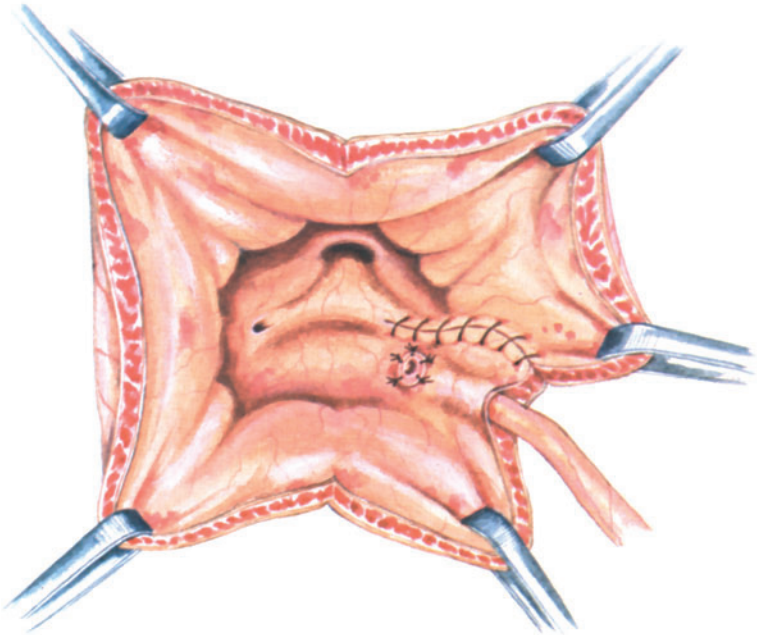
50-3. *An indwelling urethral catheter (20–22 French) is inserted.* Anterior to the point of entry of the ureter the bladder edges are reapproximated and sutured. Care is taken to avoid coagulation of the ureter, which lies posteriorly. The remaining portions of bladder wall are doubly sutured with 3-0 chromic catgut.

51. Radical Cystectomy and Lymph Node Dissection

This procedure is indicated when evidence for bladder carcinoma of moderate grade (II or III) invading bladder muscle has been confirmed by pathological study after previous transurethral resection of bladder tumor. The tumor may also be multifocal. An intravenous urogram may confirm muscular infiltration near the ureteral orifice if obstruction is demonstrated by X-ray. We believe that computed tomographic scans of the bladder and bony pelvis may ultimately provide the best means of staging infiltrative bladder carcinoma.[4]

We use the supine position for radical cystectomy and prostatectomy. If the bladder tumor has migrated to the prostate, then a total urethrectomy is indicated; in this instance we use a modification of the lithotomy position. The legs, with only a slight bend in the knees, are abducted and placed on surgical protective pads. Standard leg braces are used as in the abdominal-perineal procedure. Separation of the lower extremities also allows positioning of the second assistant between the thighs.

51-1. *The future site of the ileal conduit is marked* (broken circle). A midline, vertical incision 5 cm above the umbilicus, curving around the umbilicus and extending to the symphysis pubis, is used. If a urinary diversion is also planned at this operation, then the incision may be extended su-



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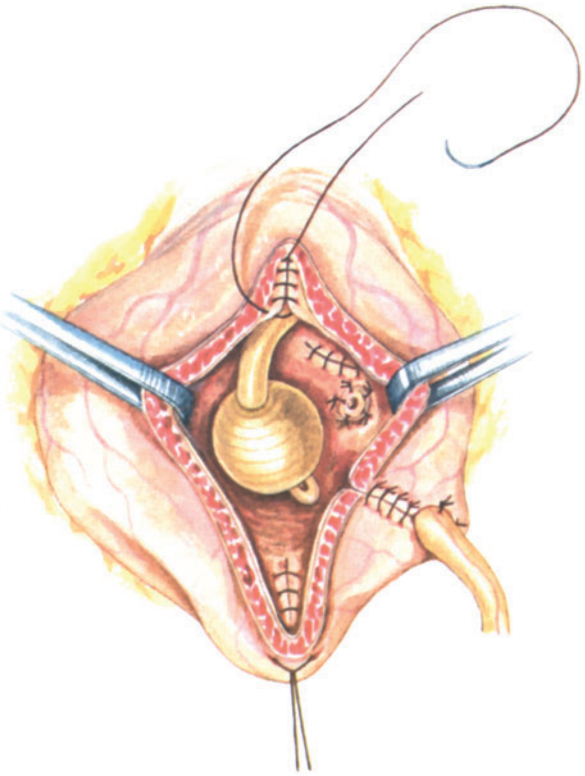
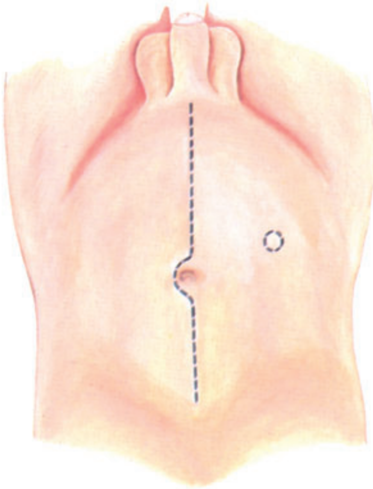


50-3

periorly for another 4–6 cm. After entering the peritoneal cavity the bladder and pelvic area are inspected and palpated. Inspection and palpation of the liver and gastrointestinal tract are also carried out.

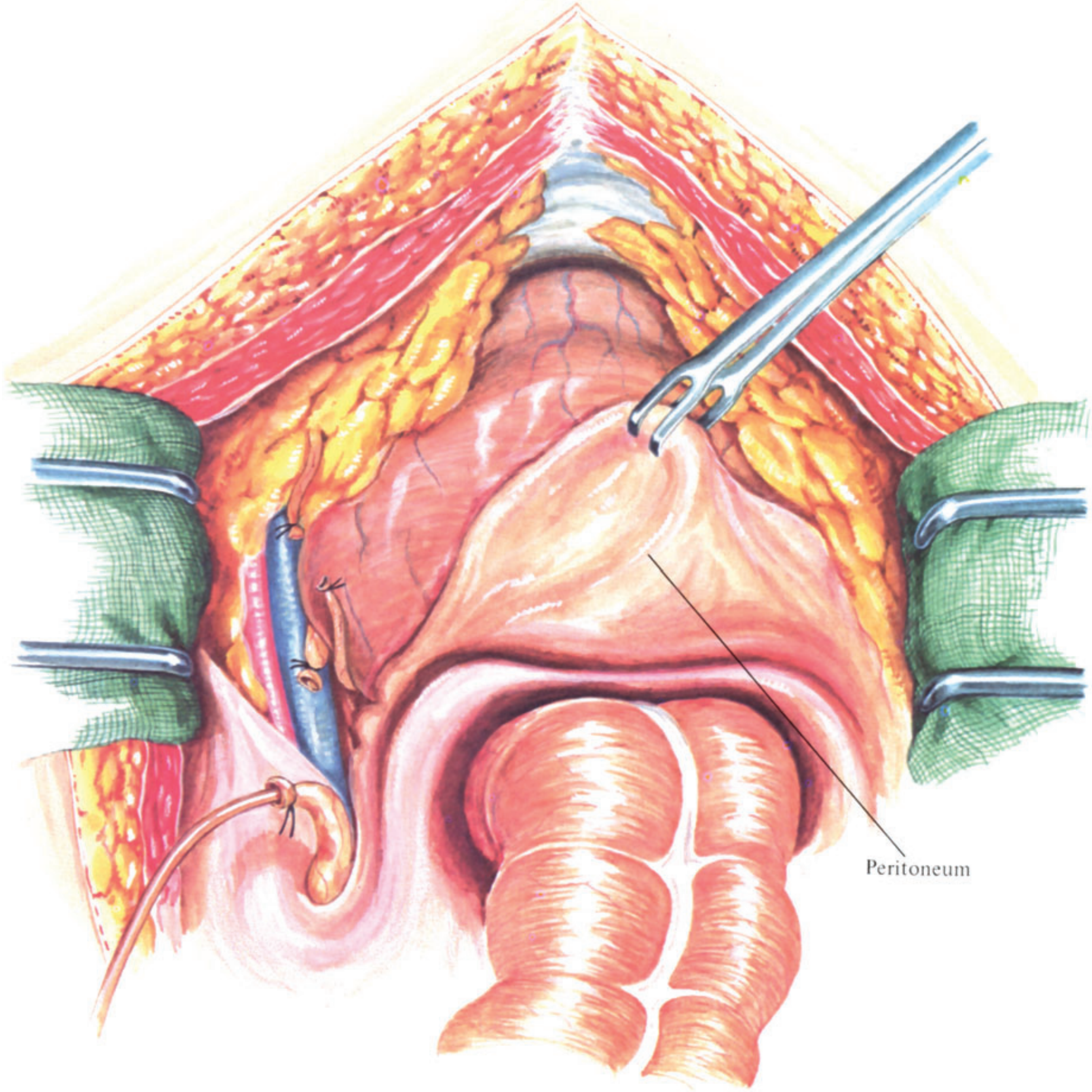
After placing the patient into a slight Trendelenberg position the small bowel is carefully packed superiorly and out of the bony pelvis. A Brunswig self-retaining retractor or a Smith ring with self-retaining retractors are carefully inserted and positioned. Only the sigmoid lies posteriorly and courses inferiorly.

Dissection begins lateral to the bladder neck area on each side to free the bladder from surrounding tissue.



51-1

51-2. *The left ureter is isolated by incising the posterior peritoneum.* The ureter is freed and divided. A distal portion of ureter is sent to pathology for frozen section. The proximal ureter is catheterized. Lymph node dissection is begun at the bifurcation of the common iliac arteries. Areolar and connective tissue are removed on the left side between common iliac artery



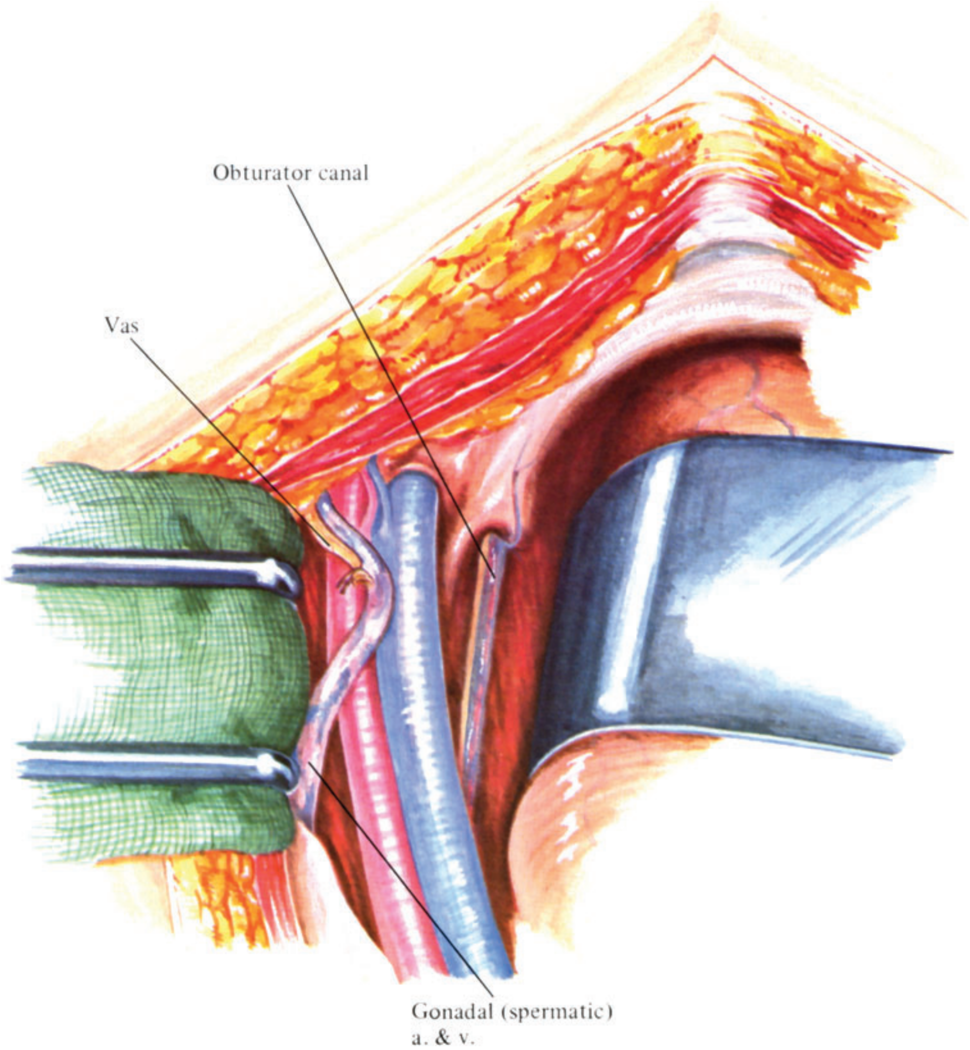
51-2

and iliac vein where the dissection continues laterally and inferiorly. The obturator nerve is freed and retracted laterally in the obturator bundle, allowing excision of areolar and lymphatic tissue. The obturator artery can be identified as the dissection continues to the femoral canal.

51-3. The circumflex vein is located at the inferior border of dissection on the left. The lateral border of dissection is the genitofemoral nerve. After dissecting and isolating the left hypogastric artery, the left superior vesical artery is freed, double ligated and transected.

51-4. The obturator artery and middle hemorrhoidal artery are also doubly ligated and transected on the left.

On the right side the dissection proceeds inferiorly and lateral to the iliac vein. The common iliac artery is freed by dissecting between the vessels. The hypogastric artery is isolated and the right ureter is carefully retracted. The ureter may be divided at this point. The distal tip of the ureter is separately divided and sent to pathology for a frozen section. The proximal ureter is cannulated with a soft ureteral catheter (6 French) and allowed to drain outside the patient.



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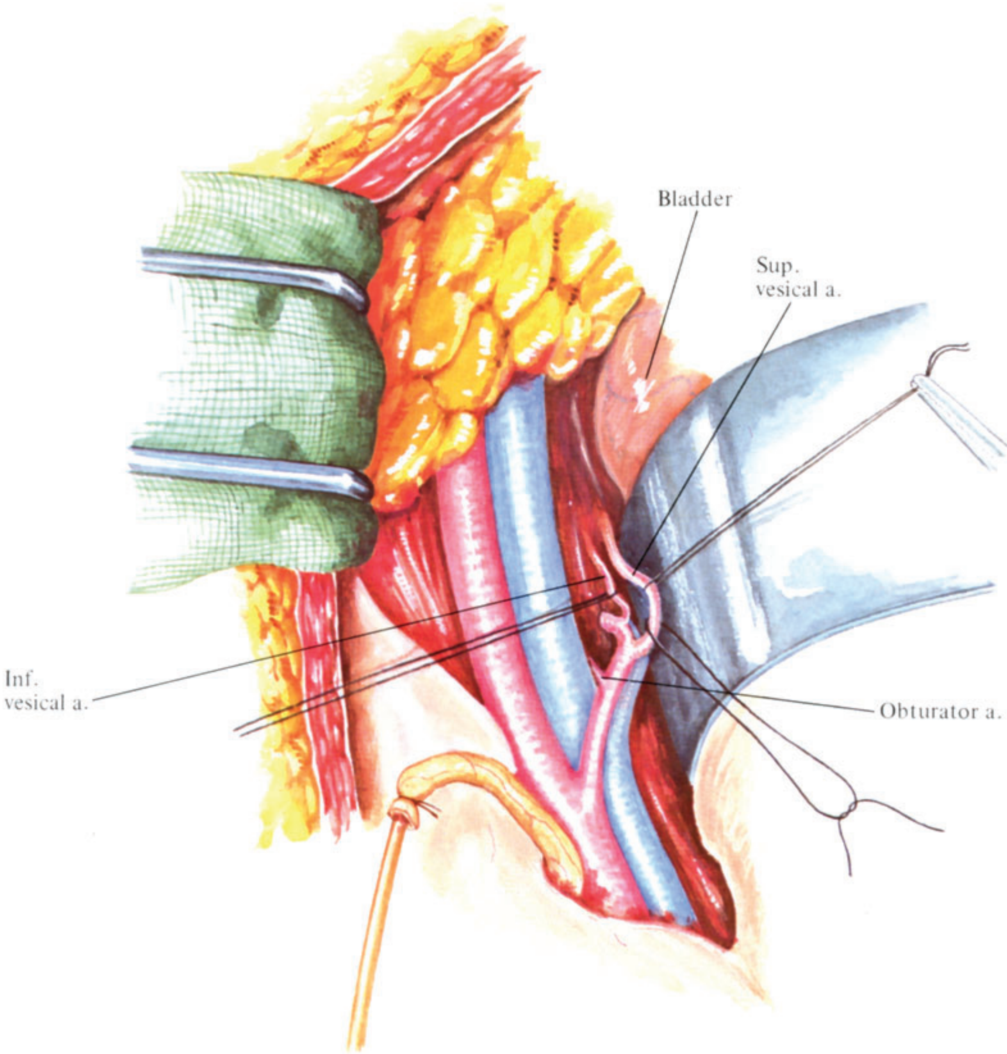


51-4

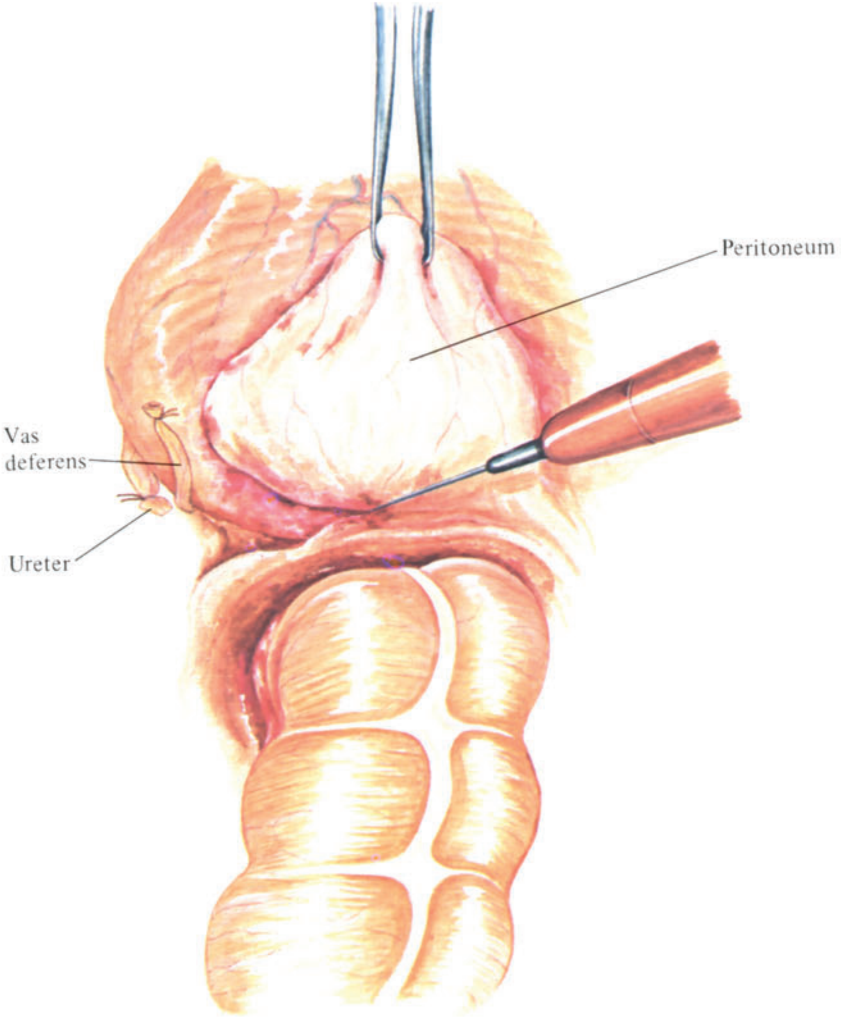
Dissection is continued along the right obturator bundle to the femoral canal. The hypogastric artery is carefully dissected distally, allowing double ligation and transection of the right superior vesical artery, obturator artery and middle hemorrhoidal artery.

51-5. Removal of the bladder is now facilitated by *incising the peritoneal reflection close to the rectum and proceeding inferiorly*. The assistant lifts the bladder as the surgeon frees the posterior bladder wall. The inferior vesical arteries can now be isolated.

51-6. The plane between prostate and rectum can also be initiated.

51-7. Both inferior vesical arteries are doubly ligated and transected.

51-8. The bladder is elevated with a tenaculum. The prostate and seminal vesicles are seen along with the ligated vessels supplying the bladder and prostate. The urethral-indwelling catheter is now brought into the field. Formalin is introduced into the bladder (120 ml) for 5–10 min. The solution is then allowed to drain out.



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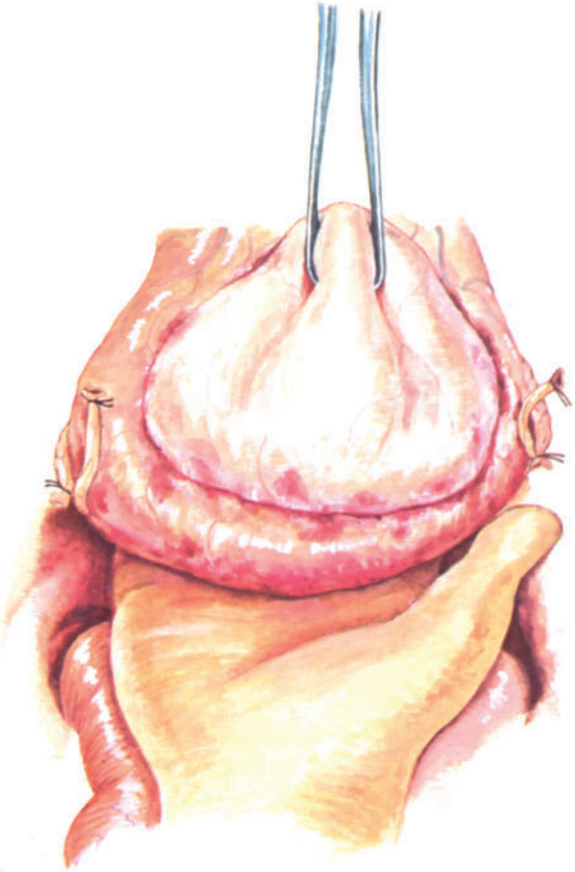

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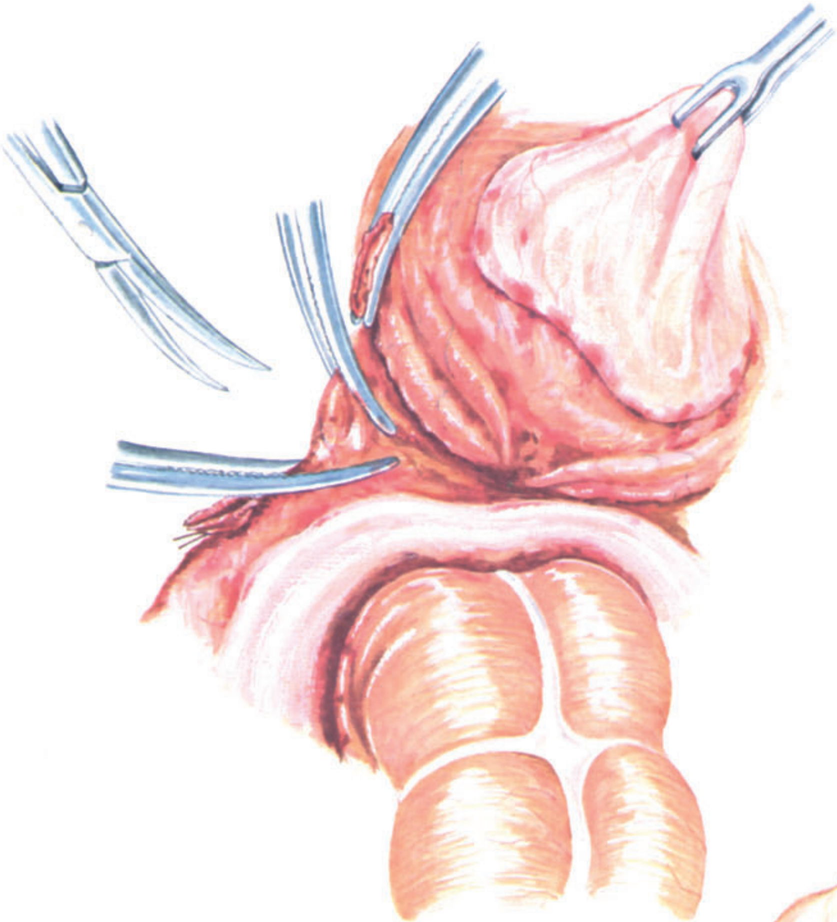

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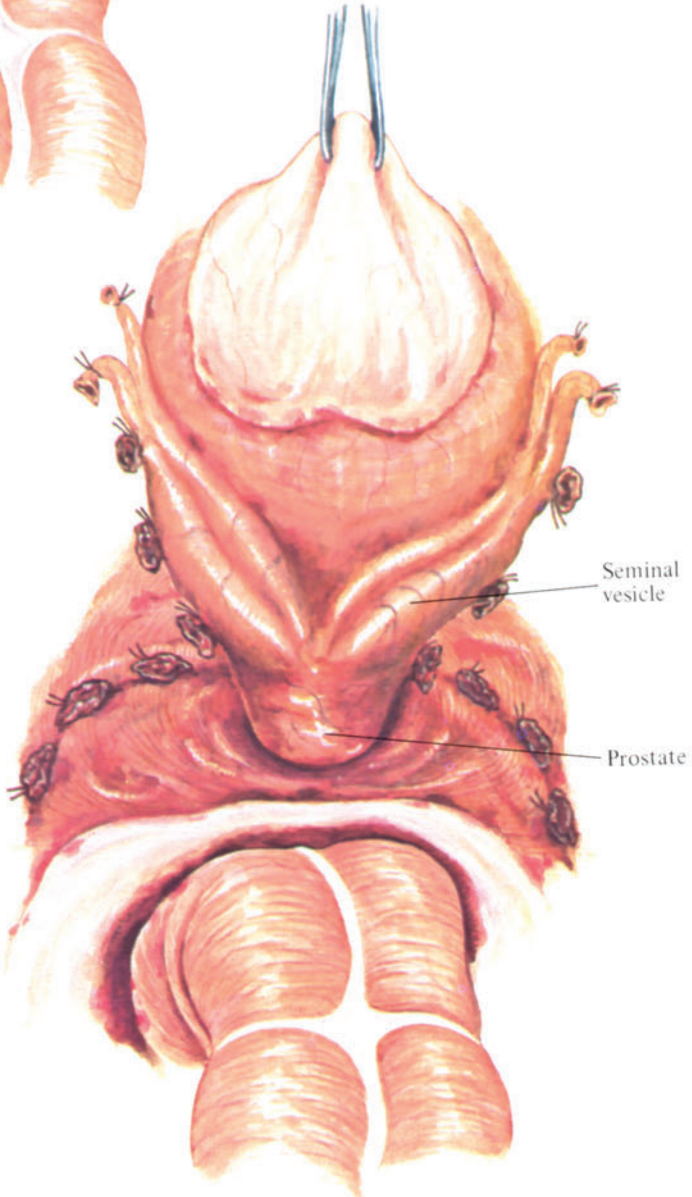

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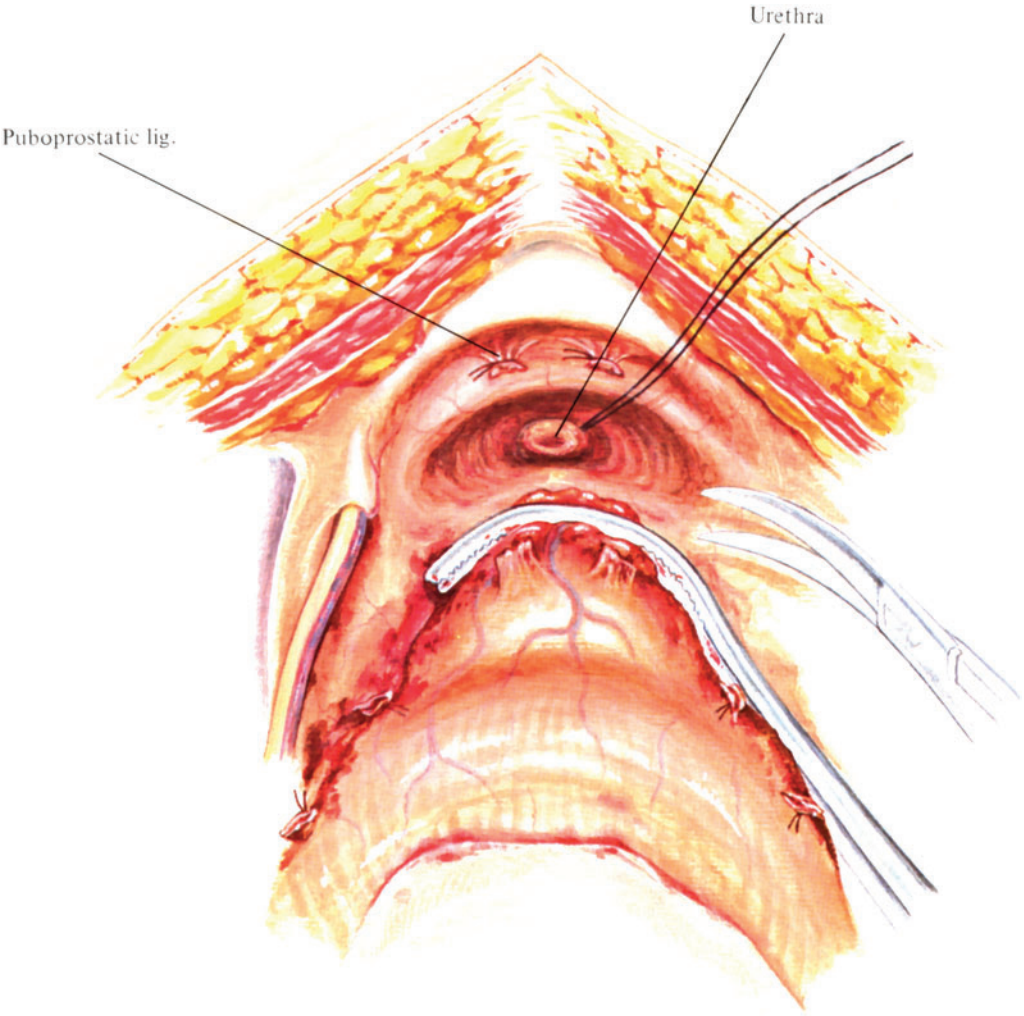


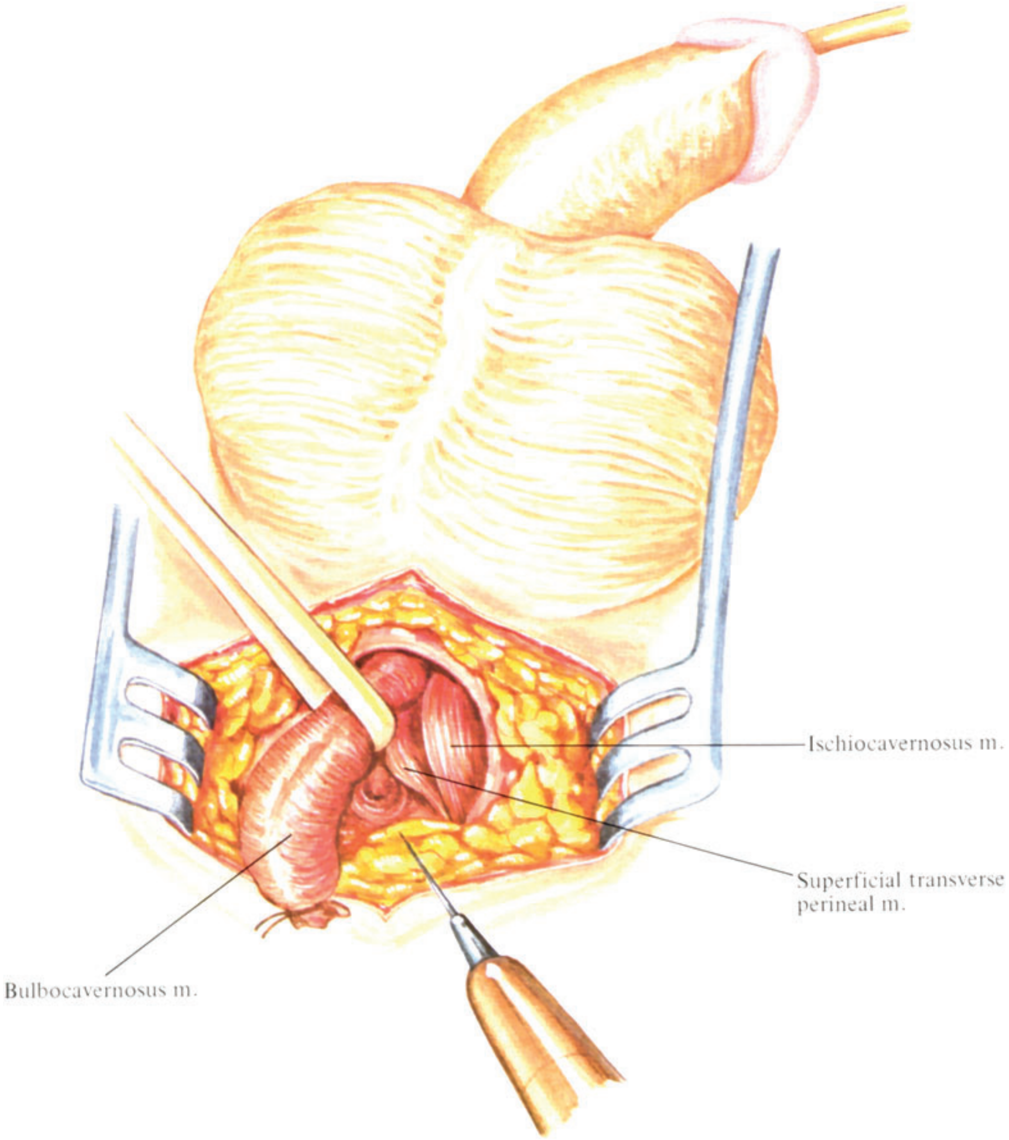
51-9

51-9. The prostate is freed anteriorly by cutting through the endopelvic fascia. The puboprostatic ligaments are divided near the pubic bones. Venous bleeding is controlled by appropriate ligatures (see surgical management of santorini plexus in Radical Retropubic Prostatectomy, 63-2 through 63-4). The urethra distal to the prostate can be isolated around the catheter. Prostate and bladder are removed en bloc after transecting the catheter and attaching a clamp to the proximal catheter to provide upward traction. A surgical pad can be used to pack the former prostatic bed to control bleeding. An alternative is urethral passage of a second indwelling urethral catheter. Inflating the balloon and providing gentle traction is helpful. The procedure is now continued, and an ileal conduit is constructed. A total urethrectomy may also be indicated in selected instances.

52. Urethrectomy Following Total Cystectomy and Prostatectomy

The supine patient is now repositioned (lithotomy) to allow access to the perineum. Resterilization of the perineum may be necessary, with new drapes.

52-1. *A vertical midline perineal incision is made.* The proximal urethra with its ligature is isolated and dissected. A urethral catheter or curved metal sound assists in the location of the urethra. A Penrose drain is helpful.



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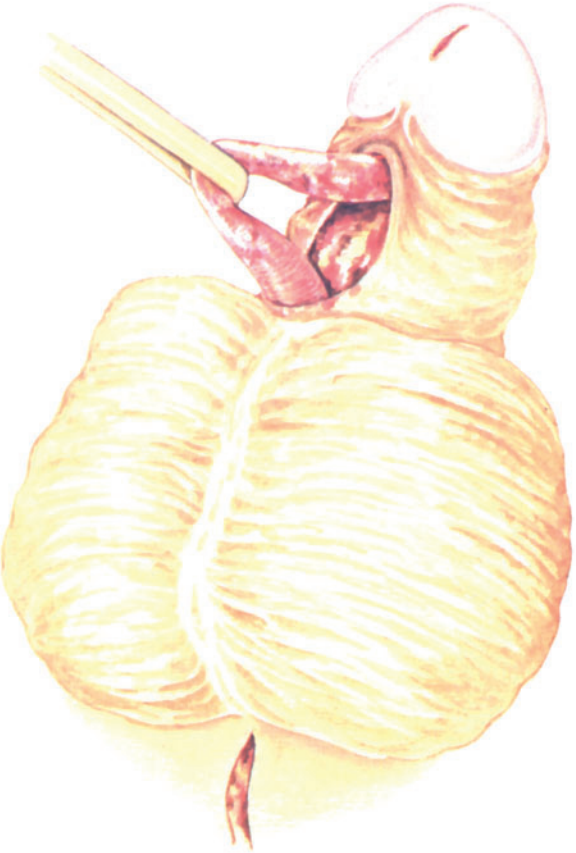

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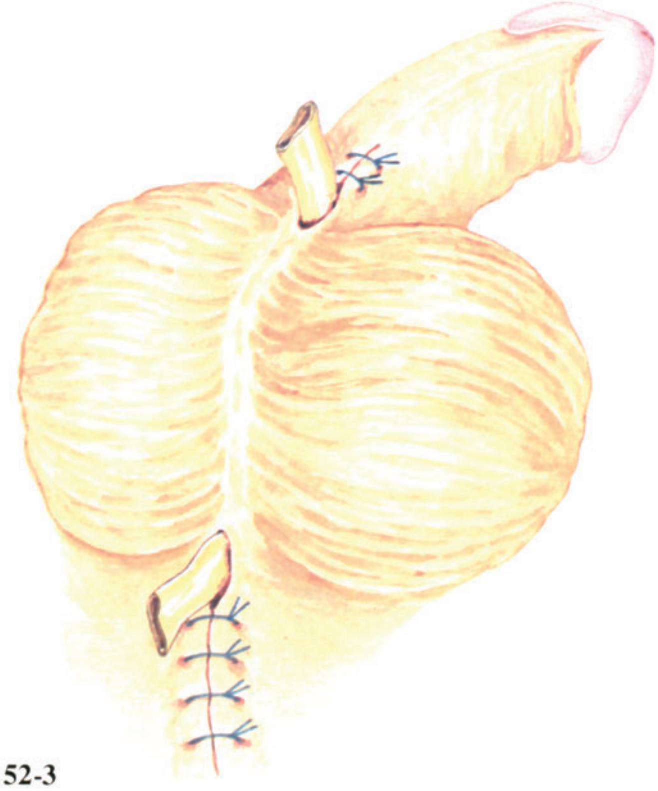


52-3

52-2. *A second longitudinal incision is made along the ventrum of the penis.* The distal urethra is isolated and freed, allowing the proximal urethra to be pulled out of the surgical opening. The distal urethra is transected and ligated at the corona. The epithelium is squamous at the urethral meatus.

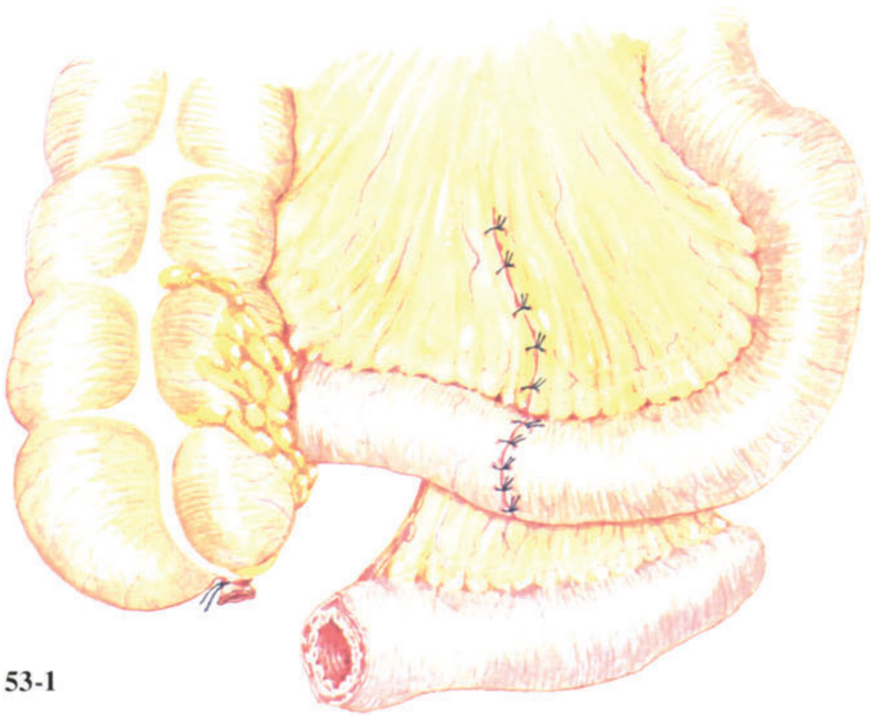
52-3. *Two Penrose drains are secured.* Skin closure of both wounds is made with interrupted sutures.

53. Isolated Segment of Ileum for Urinary Diversion (Bricker Loop[2])

53-1. This procedure is sometimes staged and performed independently prior to cystectomy. *The segment of ileum with its blood supply is prepared.* Bowel continuity is reestablished. The proximal end of the isolated ileum is closed with two layers of 3-0 chromic catgut sutures. An appendectomy is performed. The distal opening of the ileum is catheterized to flush out residual mucoid material.

53-2. *The upper segment of the left ureter must now be carefully guided behind the mesosigmoid to a new location in a more medial position.* Care must be taken to prevent kinking in the upper left ureter.

Each ureter is brought through the posterior peritoneum and cut on a bias. An opening in the antimesenteric border of the ileum is made to accommodate the exact diameter of each ureter. Redundant mucosa is usually included in the small button of ileal wall removed. The ureteral anastomoses are made using 4-0 chromic catgut. The size of the intestinal conduit is noted so that an appropriate incision can be made at the pre-



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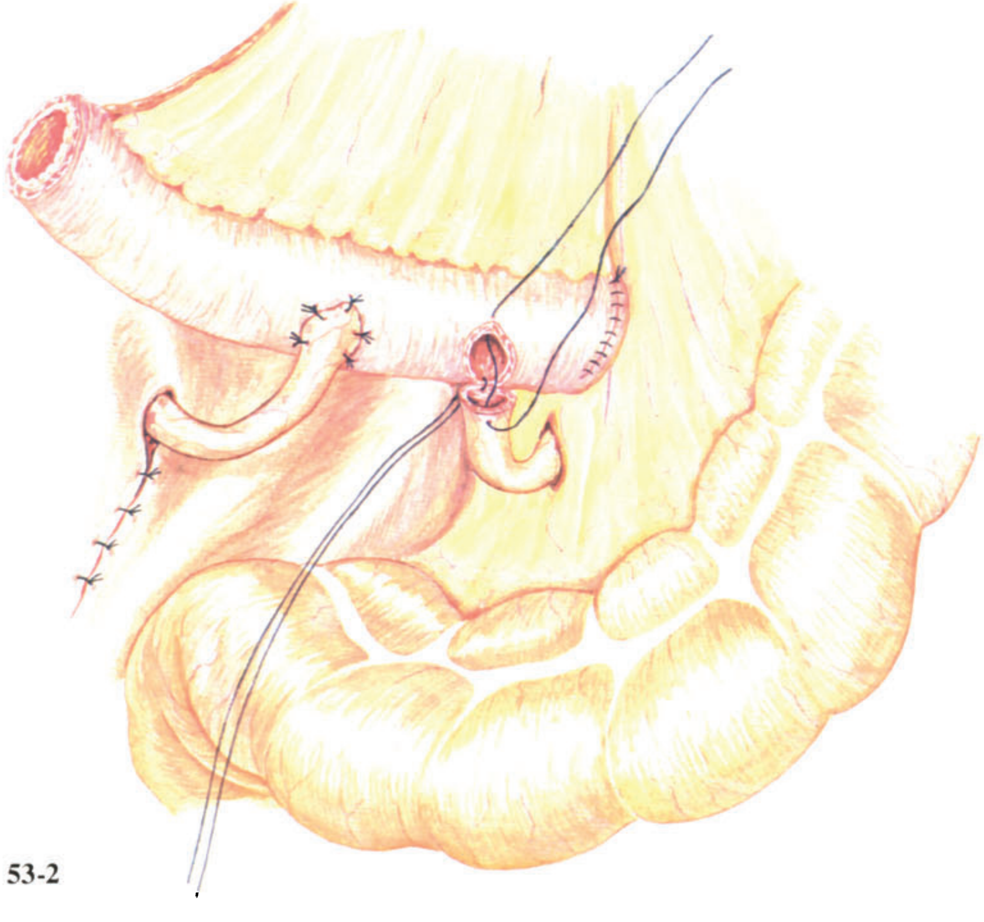
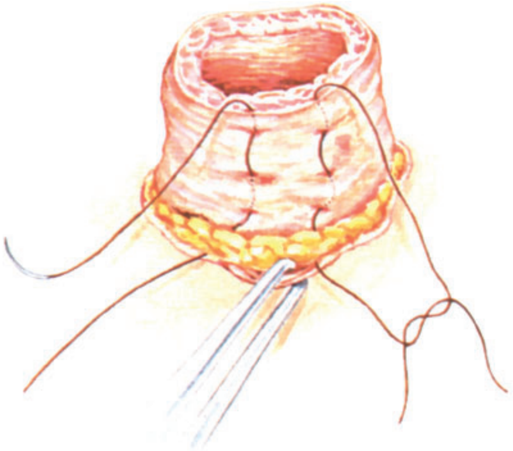


53-2

viously determined skin site (see Fig. 51-1). A circumferential button of skin is excised. A similar size circle of fascia is removed. The abdominal muscles are separated by blunt dissection. A button of anterior peritoneum is removed. The opening in the abdominal wall is ready to accommodate the distal isolated segment of ileum.



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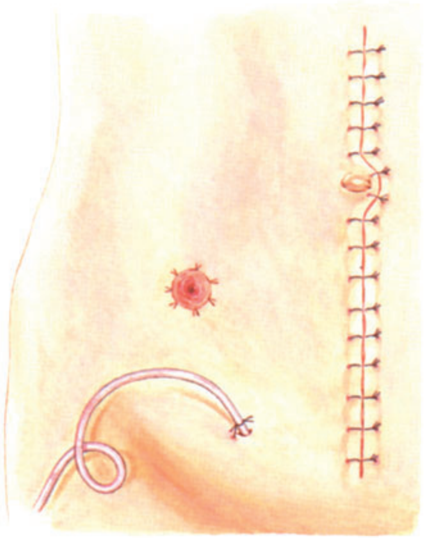


53-4

53-3. *The distal ileum is grasped and gently pulled through the stoma* with Allis clamps. The ileum is secured to the anterior peritoneum to prevent potential herniation. The ileum is then sutured to the fascia. Prior to eversion chromic catgut (3-0) stitches are placed circumferentially.

53-4. *The ileum is everted into a cuff.* The interrupted sutures are tied. A hemovac tube is positioned as shown to drain the pelvic cavity and is secured to the skin for 4–6 days. The muscles are reapproximated. The fascia is closed with interrupted nylon sutures (1-0). The abdominal skin is closed with interrupted sutures.

54. Alternate Procedures for Urinary Diversion

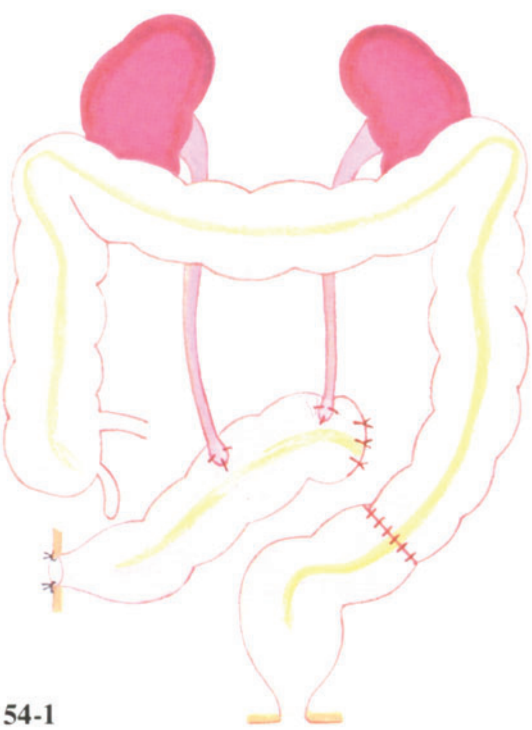
54-1. *Urinary diversion using a segment of sigmoid colon.*

Although depicted anteriorly by the following schematics, the operative technique includes placement of the distal ureters in a posterior location. An antireflux procedure can be performed, as described for Figs. 40-6 to 40-9.

54-2. *A rectal bladder and a concomitant colostomy*

54-3. *A rectal bladder.* Instead of colostomy *the sigmoid colon is brought inferiorly anterior to the rectum and brought through the anal sphincter.*

54-4. *The sigmoid colon is brought posterior to the rectum.*



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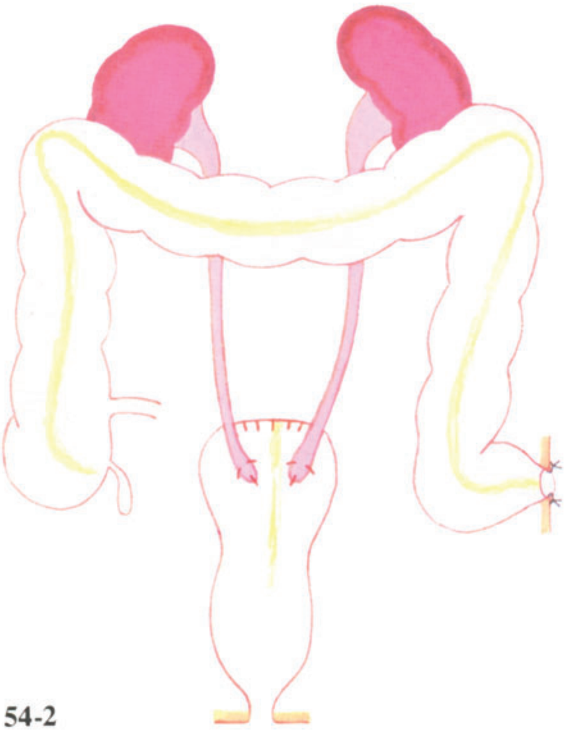

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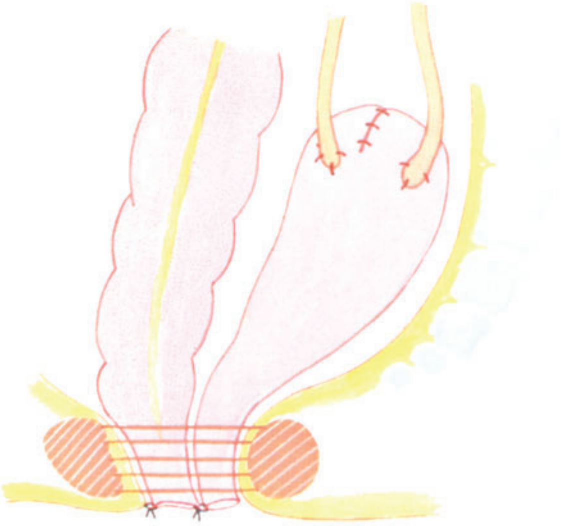

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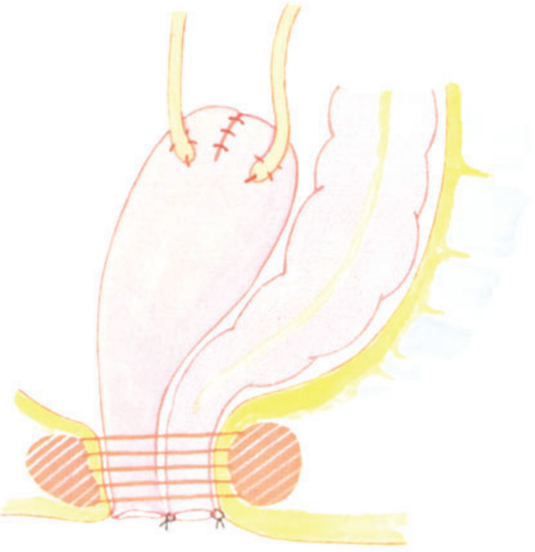


54-4

Bladder Enlargement

Candidates for the bladder-enlarging operation include patients with tuberculous cystitis, interstitial cystitis, or chemical cystitis. A bowel preparation, including the use of antibiotics is indicated as follows:

For large bowel surgery the patient is hospitalized 72 hours prior to surgery. In selected well-motivated patients the preparation can be started at home.

For small bowel surgery the patient is hospitalized 48 hours prior to surgery.

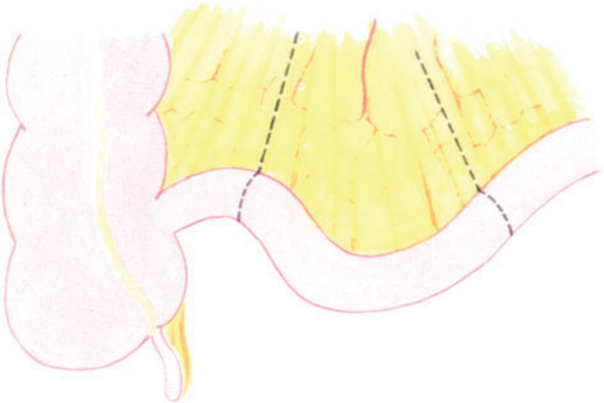
1. A low-residue diet is begun and continued during the preoperative period.
2. Enemas (tap water) are given once daily until the day before surgery, when enemas are given twice a day.
3. A laxative, 16 ml aqueous solution of sodium phosphate (Phospho-Soda), is given twice daily throughout the preoperative period.
4. Neomycin (500 mg) and tetracycline (250 mg) are given orally four times daily until surgery. An alternative antibiotic protocol includes 1 g neomycin and 1 g erythromycin base, given three times on the day prior to surgery. Both medications are given orally at 1300, 1400, and 2300 the day before surgery.

55. Goodwin Cup Patch Technique[3]

55-1. *A segment of ileum is isolated.*

55-2. *The ileum is opened along its antimesenteric border.*

55-3, 55-4. *A cup patch is formed.*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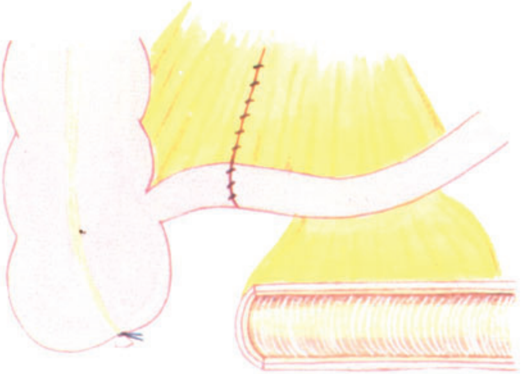
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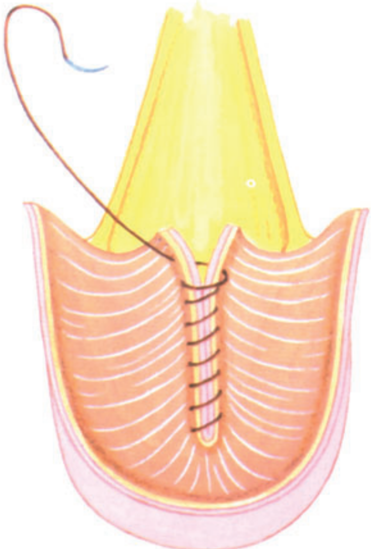
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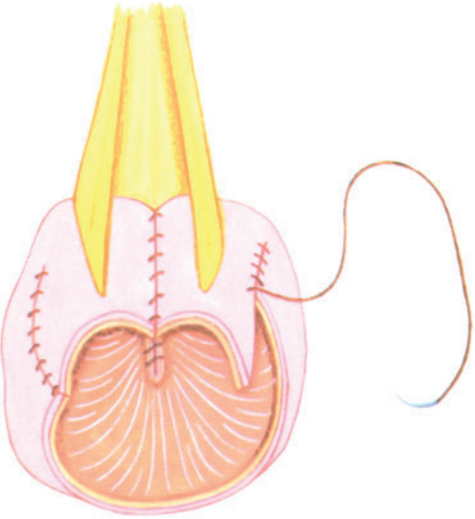
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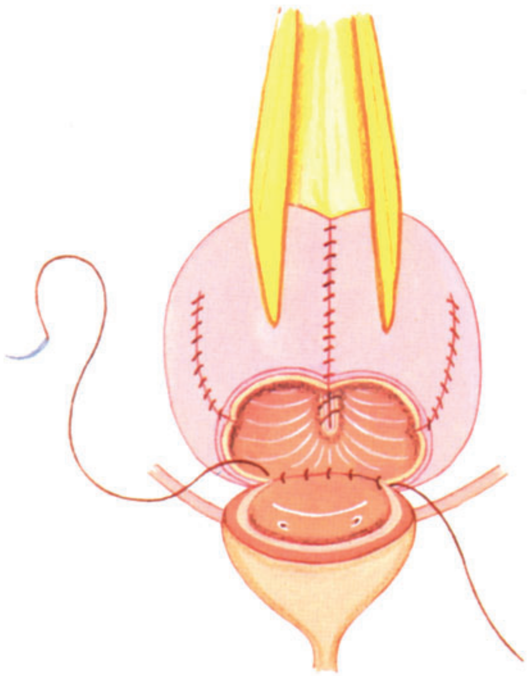


55-5 55-6

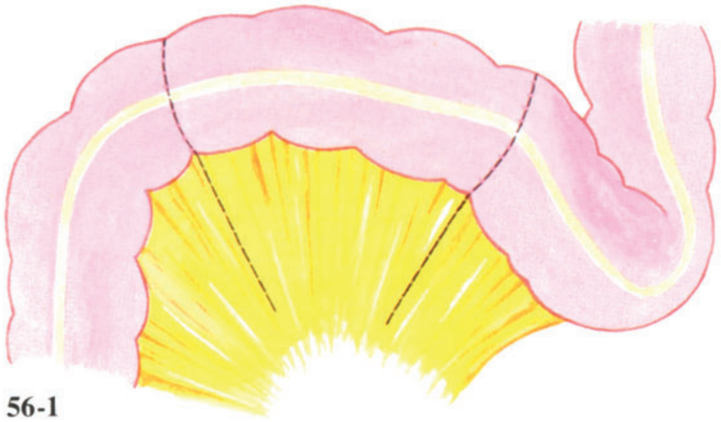
55-5, 55-6. *The ileum is anastomosed to the open bladder.*

56. Sigmoid Cystoplasty

A subtotal cystectomy is performed.

56-1. *A segment of sigmoid colon is isolated* after bowel preparation.

56-2. The sigmoid is positioned, and *both ends are closed with 3-0 chromic catgut, and an opening to fit the bladder is made* on the antimesenteric border.



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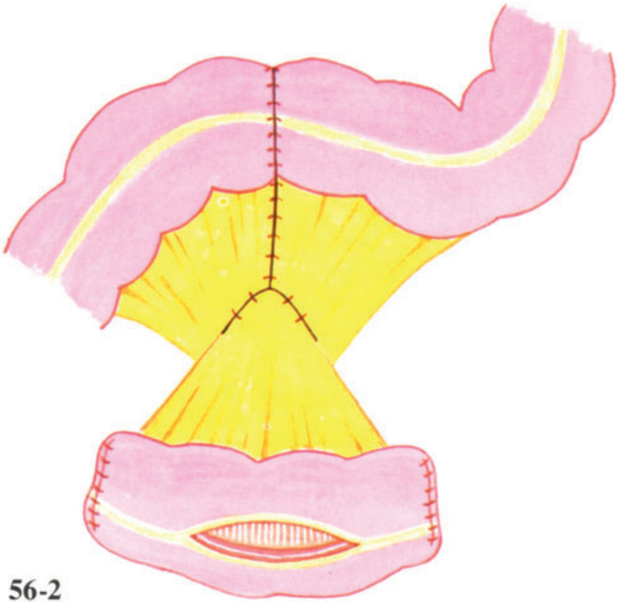
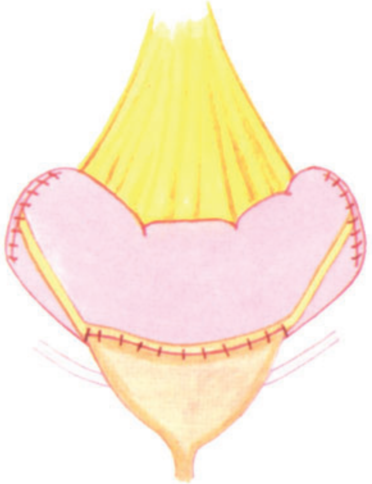


56-2

56-3. *The sigmoid segment is attached to the bladder.*

56-4. Because of bladder irritability and urinary incontinence, *the ureters are implanted into the sigmoid* (anti-reflux procedure). The trigone and lower ends of the ureter are removed. The ureters lie posteriorly.



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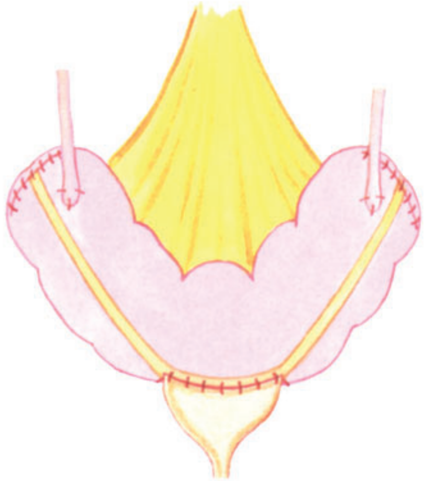

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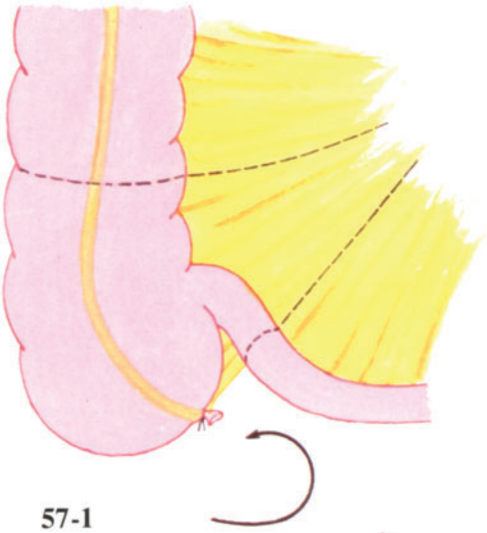

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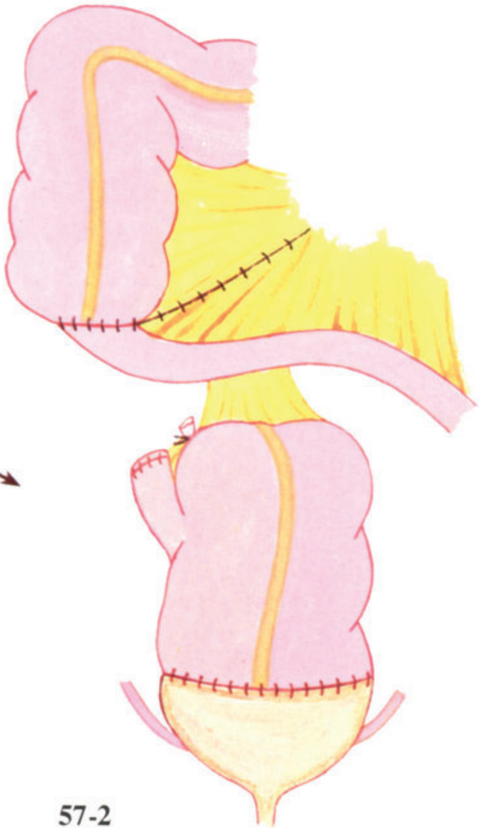

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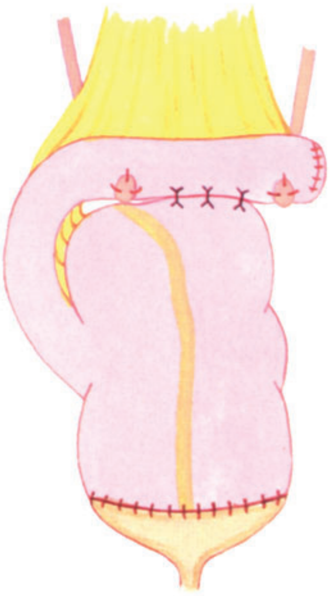


57-3

57. Cecal Bladder Construction

57-1. *The cecum and the terminal segment of the ileum are isolated surgically* prior to an appendectomy.

57-2. Reestablishment of *bowel continuity is accomplished by end-to-end anastomosis, cecum to ileum.* A 180° counterclockwise rotation is made of the isolated cecum for anastomosis to the bladder.

57-3. In selected instances *the ureters can be anastomosed to a slightly longer segment of ileum.* Urinary reflux is prevented by the ileocecal valve.

Vesicovaginal Fistula

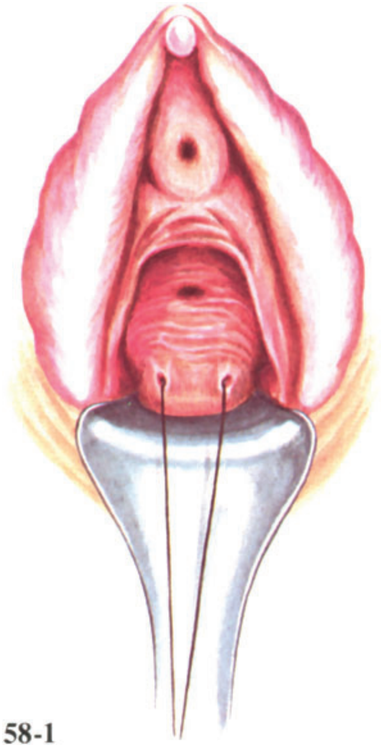
Previous reconstructive or gynecologic surgery involving the roof of the vagina and adjacent bladder can lead to development of a urinary fistula. The added factor of infection may complicate matters. We believe that edema and infection must subside before healthy tissue can be used to surgically cover the defect. This healing period may last 3–5 months in some instances.

Careful work-up of each patient is mandatory. An intravenous urogram should be performed. One should be certain that the patient does not have a ureterovaginal fistula. Cystoscopy should be performed. One can usually find the bladder opening and its proximity to the ureteral orifices.

58. Vaginal Approach

58-1. The patient is in the lithotomy position. *The vesicovaginal fistula is exposed after* a weighted vaginal speculum is inserted and stay sutures are placed for tension.

58-2. *A urethral indwelling catheter is inserted into the bladder* through the fistula. The bag is inflated and placed under tension. The broken line indicates the contour for incision.



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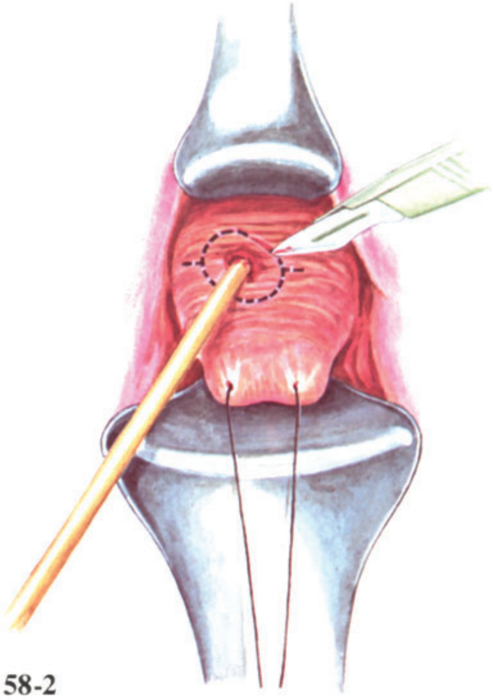


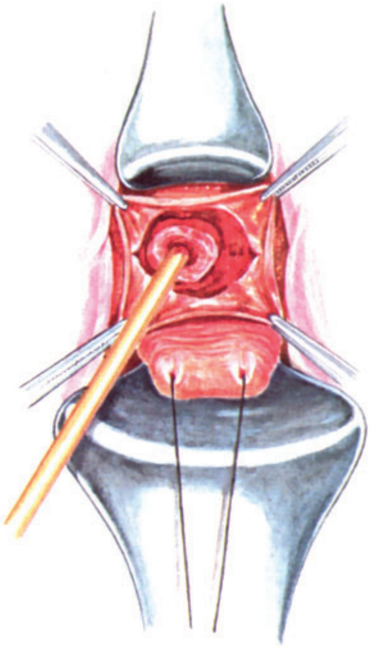
58-2

58-3. *The fistula, with a ring of normal tissue, is excised.*

58-4. *The fistulous plug can be easily withdrawn* from the operative site. Indigo-carmine dye is injected intravenously at this point to help in visualizing the ureteral orifices.

58-5. The bladder wall, muscular septum and vaginal wall are closed in separate layers. The inner layer is closed transversely. *The middle layer is closed longitudinally.*

58-6. *The outer layer is closed transversely.* The stay sutures are removed. A urethral indwelling catheter is left in place (18–20 French) for 5–8 days.



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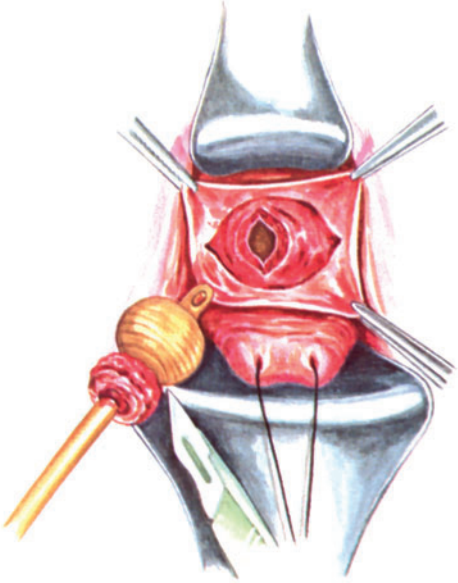

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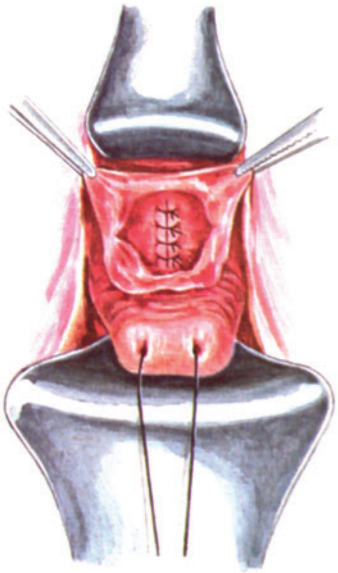

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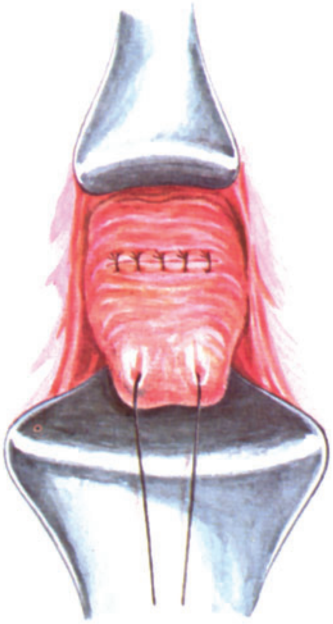


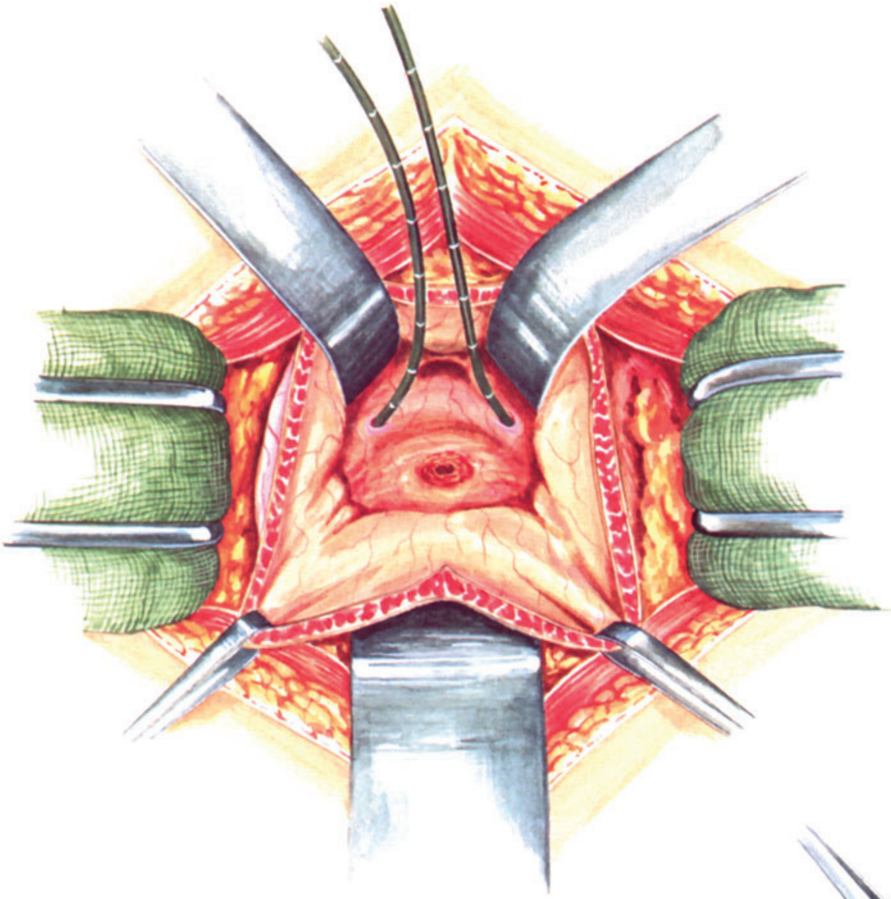
58-6

59. Transperitoneal-Transvesical Approach

The approach to the bladder is a lower vertical midline incision.

59-1. *The bladder is opened anteriorly.* The ureters are catheterized (5 French). The fistula is observed.

59-2. *The superior and posterior walls of the bladder are raised.* A transverse incision is made through the posterior peritoneum, freeing the layer of peritoneum from bladder wall. The vertical bladder portion of a T-shaped incision is indicated by the broken line.



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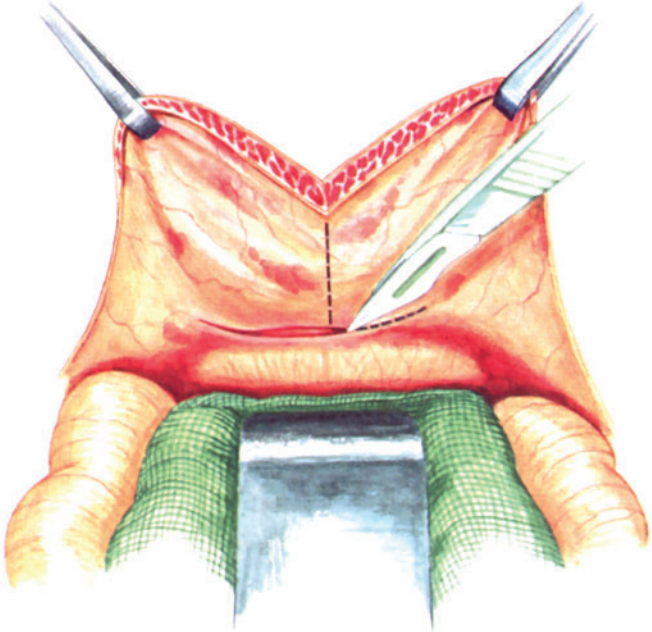
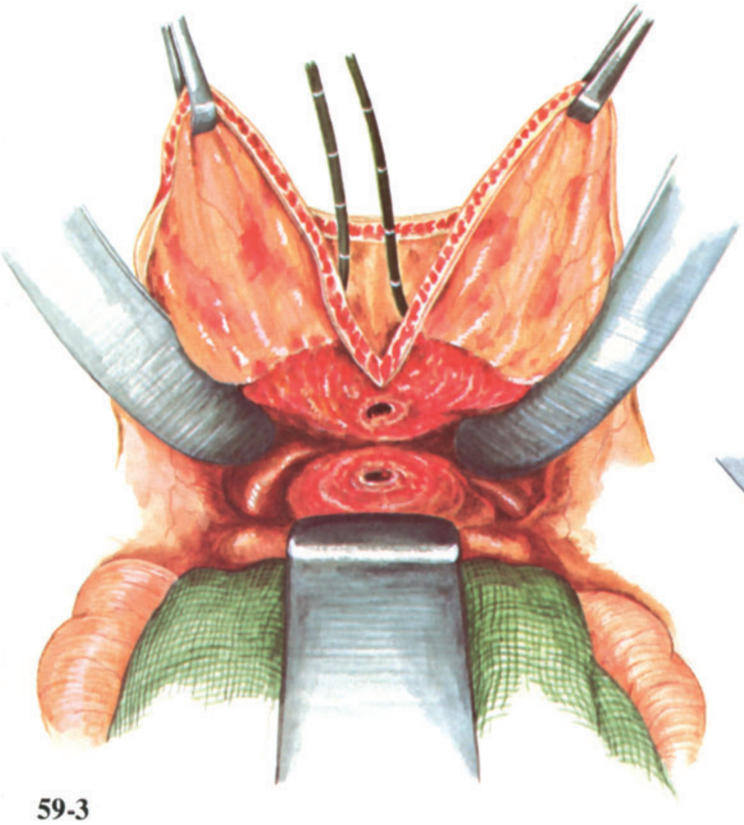


59-2

59-3. The posterior peritoneal layer is retracted out of the field, the posterior bladder wall is elevated with Allis clamps, and *the vaginal wall and adjoining bladder wall are sharply incised and separated horizontally* to clearly demonstrate the fistulous sites. The vertical extension (stem of T) through the bladder wall is carried posteriorly to include the bladder portion of the fistula.



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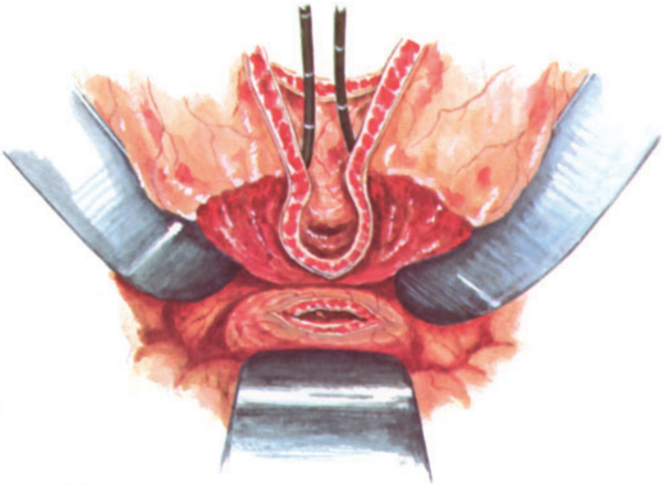

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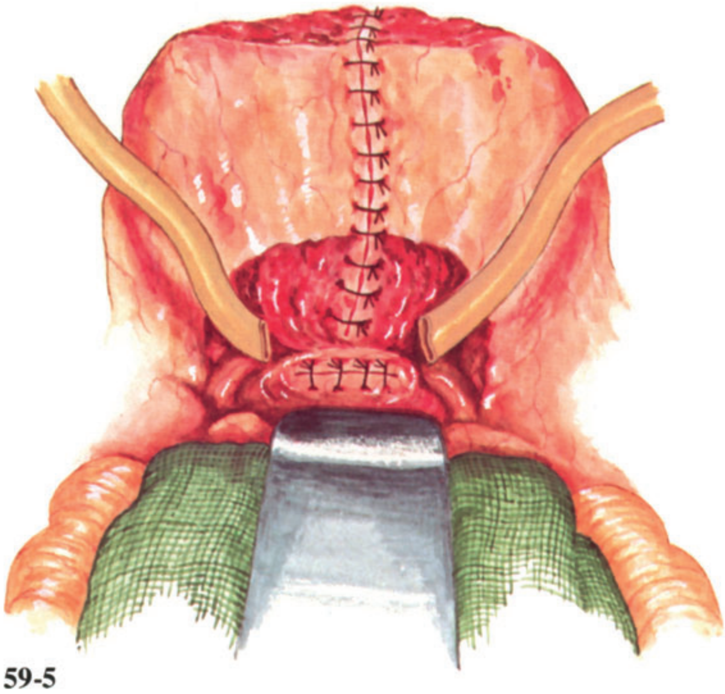

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59-4. *The vertical extension* carried posteriorly through superior bladder wall *includes the fistulous plug and a rim of normal bladder tissue.* A ring of normal vaginal tissue surrounding the fistula is also removed. The bladder neck can be visualized. Catheters assist in protecting the ureters.

59-5. *The vaginal wall is closed in several layers.* The line of suture is at right angles to the previous layer. The bladder is closed in two layers. Drains are secured. Bladder closure is in the usual fashion, using two layers. A suprapubic cystostomy, placing the catheter tip near the anterior wall, is preferred over a urethral indwelling catheter.

Fascial and skin closure are performed in the usual fashion.

60. Peritoneal Flap Technique

60-1. *A peritoneal flap is made.*

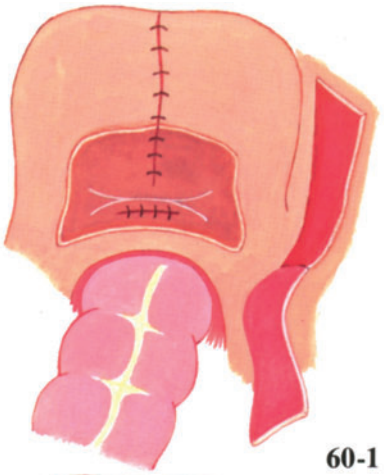
60-2. *The flap is interposed between bladder and vagina* at the site of the previous fistula and is secured.

61. Omental Flap Technique

61-1. *An omental flap is prepared* if the lower omentum cannot be brought to the bladder with ease.

61-2. *The omentum is brought inferiorly and appropriately secured* along the lateral aspect of the descending colon. The blood supply is maintained by placement of sutures.

In the next two figures the view is from a surgical vantage towards the symphysis pubis.



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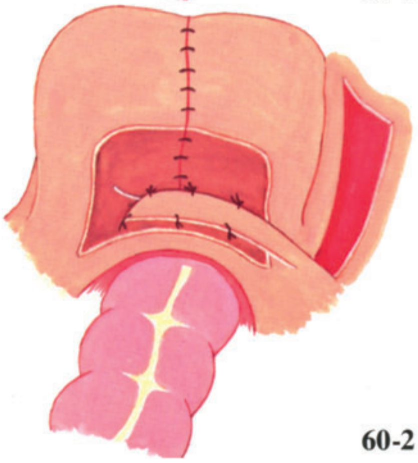

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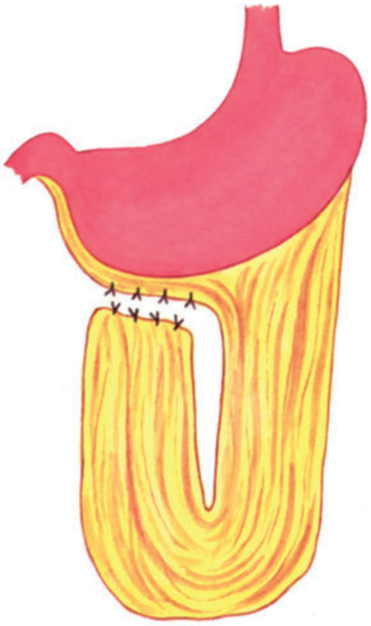

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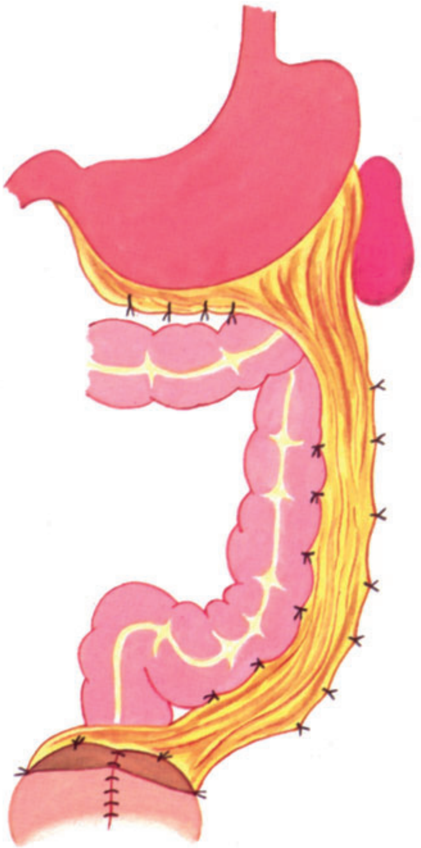

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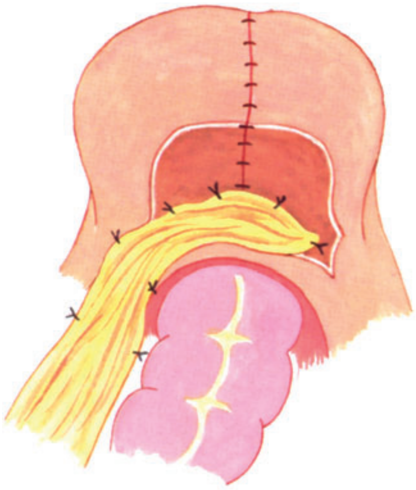

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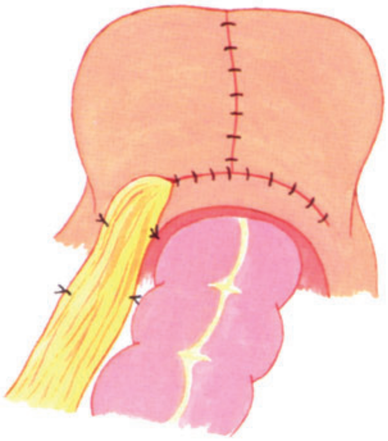

61-4

61-3. *Omentum is positioned and secured.*

61-4. *Final closure of posterior peritoneum to secure the omentum.*

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The Prostate

4

Surgical Anatomy

Structure and Location

The prostate is a multilobar glandular and fibromuscular organ that surrounds the first part of the urethra between the bladder and the urogenital diaphragm; it is covered by a fibrous capsule.

It is roughly truncated in shape, with its base contiguous with the bladder and its apex pointing toward the urogenital diaphragm (Fig. 1).

The prostate consists of five lobes: anterior, posterior, median, and left and right lateral lobes (Fig. 2). The anterior lobe has fewer glandular elements, and adenoma rarely occurs in this location. The posterior lobe lies behind the median lobe, forming the entire posterior surface of the gland, and is the lobe palpated during rectal examination. Primary adenocarcinoma may occur in this lobe as a palpable nodule.

The median lobe is clinically an important lobe. It lies in front of the ejaculatory ducts, below the neck of the bladder, and contains much glandular tissue. Adenomas frequently grow in this lobe and may lead to urinary obstruction.

Both lateral lobes contain much glandular tissue in the elderly male. Hyperplasia of the inner (periurethral) glands may form large adenomas; the outer normal prostatic tissue is displaced peripherally and compressed into a thin fibroglandular structure, which is known as the "surgical capsule." Hypertrophy of these lateral lobes is the most frequent cause of urinary obstruction in the older male.

The seminal colliculus (verumontanum) is a rounded prominence on the lower posterior surface of the prostatic urethra. It has a small depression in its central surface, the prostatic utricle. The ejaculatory ducts open into the prostatic urethra on either side of the colliculus (Fig. 3).

The prostatic glands consist of a compounded tubular structure and form about 20 ducts, which open into the prostatic urethra (Fig. 4).

Fascial Relationships

The prostate is surrounded by the endopelvic fascia, which lies outside the prostatic capsule. The puboprostatic ligaments anteriorly, triangular ligaments inferiorly, and rectovesical fascia of Denonvilliers posteriorly also

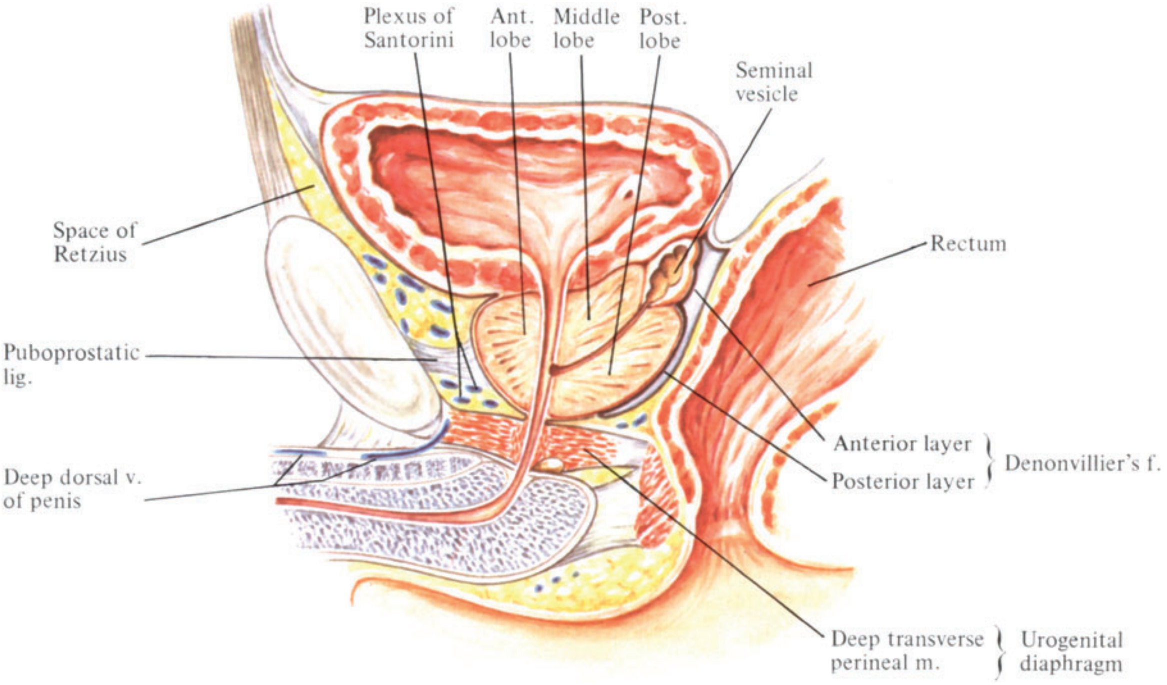


FIG. 1. Midsagittal view emphasizing fascial relationships.

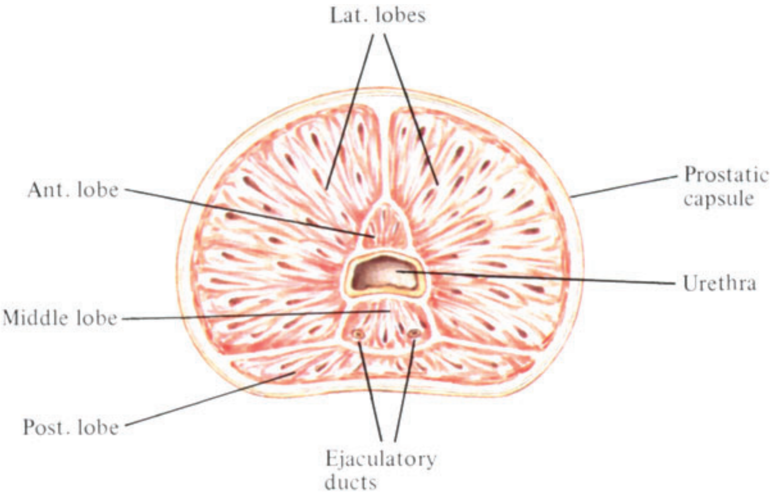


FIG. 2. Cross-sectional view, showing lobes.

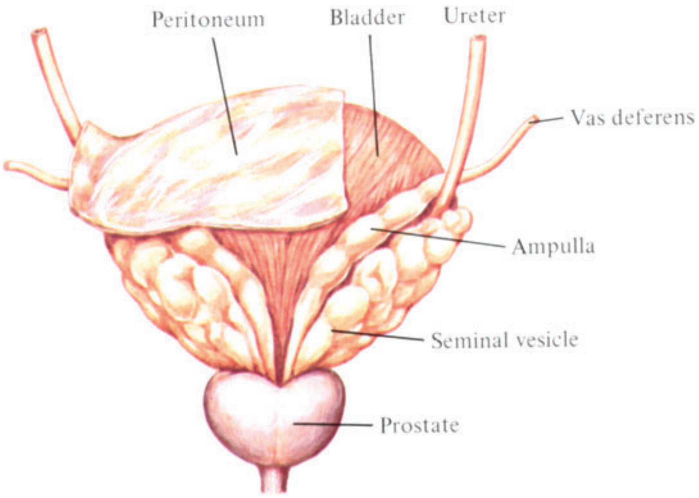


FIG. 3. Posterior view showing seminal vesicles and ejaculatory ducts entering prostate.

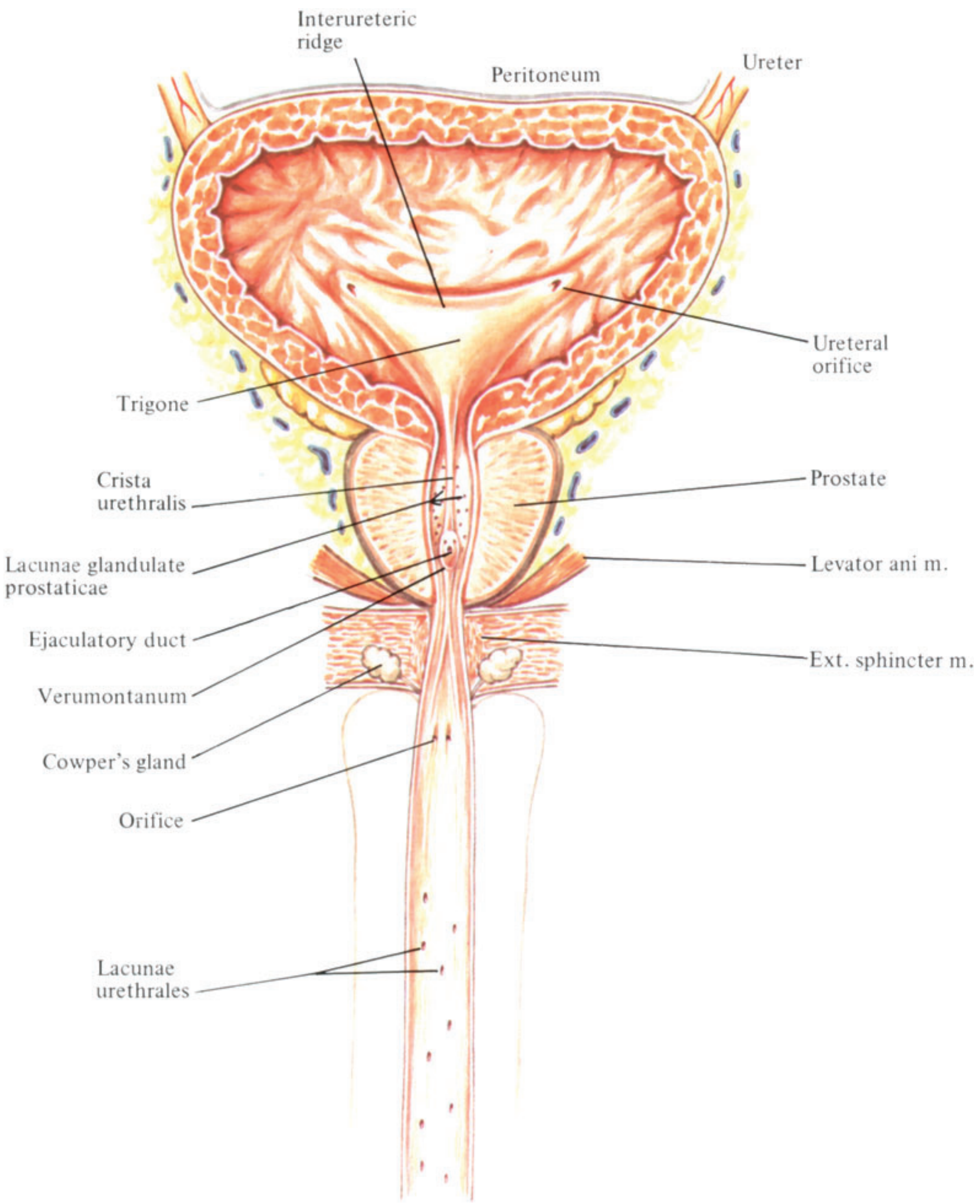


FIG. 4. Interior of bladder, prostate, and proximal portion of urethra.

surround the prostate (Fig. 1). A narrow area at the anterior midline toward the base of the prostate is left uncovered by the puboprostatic ligaments (width of one finger) (Fig. 5).

The anterior layer of the rectovesical fascia is firmly attached to the prostate and seminal vesicles, but the posterior layer is attached loosely to the pelvic fascia and separates these organs from the rectum. The space between these two layers is called the retroprostatic space of Proust and is an important anatomic landmark when total perineal prostatectomy is being performed.

The periprostatic plexus of veins lies between these surrounding fasciae and the true prostatic capsule. By dissection close to the levator ani muscle, the fascia containing blood vessels and lymphatics can be removed with the prostate and seminal vesicles when radical perineal prostatectomy is being performed.

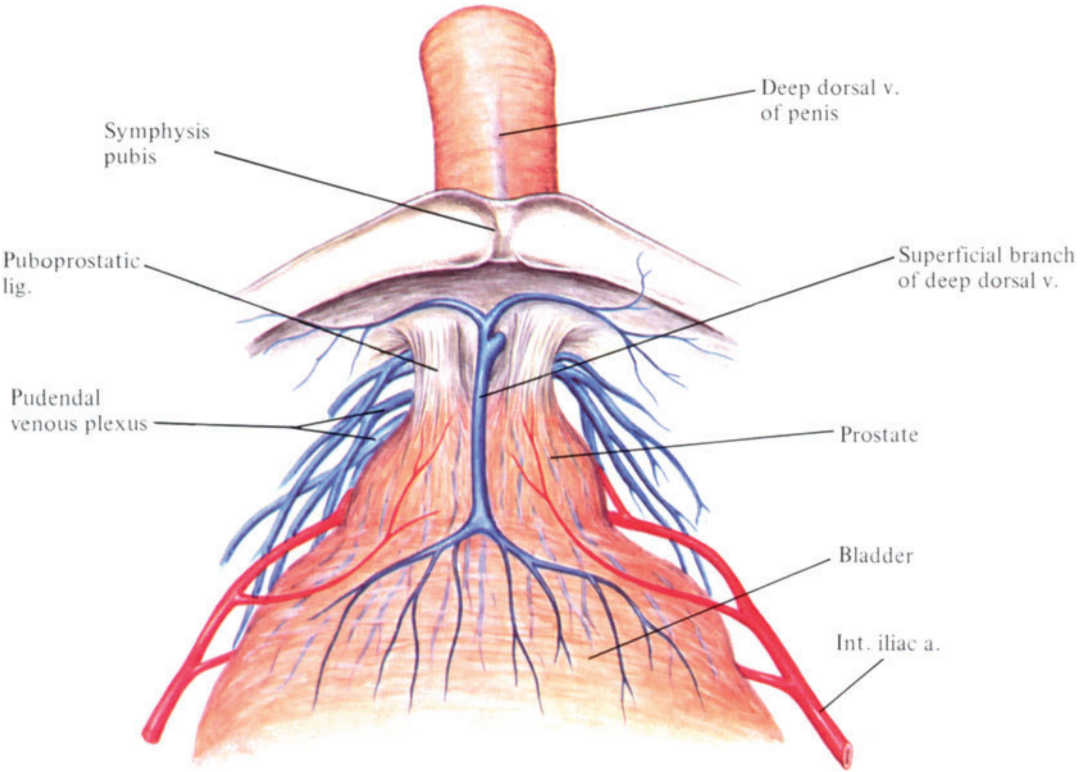


FIG. 5. Venous supply.

Vascular Supply

The main arterial supply to the prostate is derived from the inferior vesical artery, which is a branch of the internal iliac artery. Additional arterial supply is frequently received from the middle hemorrhoidal and internal pudendal arteries, which enter the gland at the vesicoprostatic junction. Flocks[3] made a comprehensive study of the intrinsic arterial distribution within the prostate and found two groups of arteries, the urethral and the capsular groups. The urethral group of arteries penetrates the capsule at the posterolateral vesicoprostatic junction and supplies the vesical neck and periurethral portion of the gland. The capsular group of arteries enters the gland laterally, giving off several branches, which supply mainly the peripheral portion of the prostate (Fig. 6). This group of arteries shows little change with age or with the development of hyperplasia.

With benign prostatic hyperplasia, the urethral group of arteries enlarges to supply the whole of the adenoma. It is an extremely important anatomic principle when a surgical procedure of the prostate is being considered. Regardless of the type of adenectomy, the main arterial bleeding will be from this group of arteries in the posterolateral quadrants of the vesical neck. Ligation or cautery of the vessels in the early stage of any type of operative procedure will minimize subsequent bleeding.

Veins form a plexus on the anterior and lateral aspects of the prostatic capsule, particularly around the base of the gland at the vesicoprostatic junction. The veins receive branches from the deep dorsal vein of the penis, communicate with the pudendal venous plexus and vesical plexus, and drain into the internal iliac veins. The superficial branch of the deep dorsal vein of the penis, which lies on the midline of the anterior surface of the prostatic capsule, is of considerable surgical importance in retropubic prostatectomy (Fig. 5).

The lymphatics from the prostate glands form a periprostatic network and unite to form several main channels and drain into the internal iliac, external iliac, obturator, and presacral nodes.

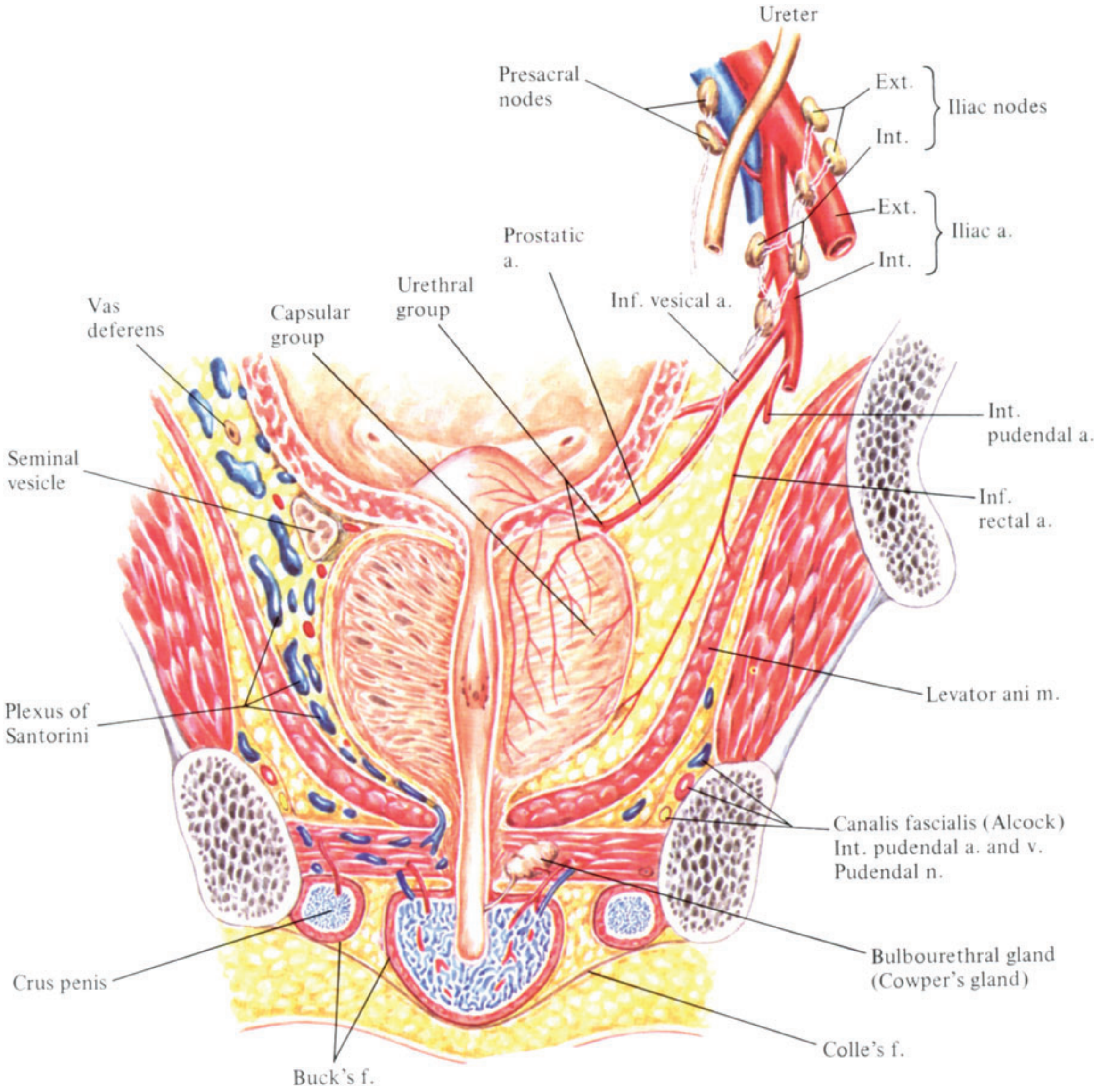


FIG. 6. Arterial supply.

Operative Techniques

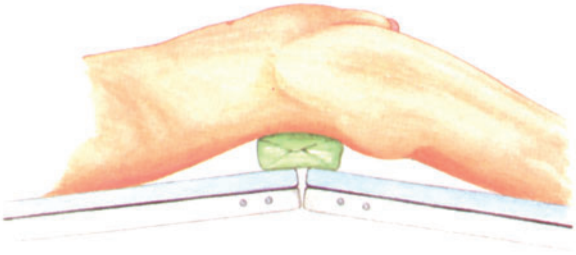
62. Retropubic Prostatectomy (Vesicocapsular Prostatectomy)

62-1. Position of the patient. *The sacrum of the patient is placed on a rectangular sandbag.* The table is flexed slightly to open the retropubic space.

62-2. *A vertical midline incision is made* and carried through skin and fascia. The rectus abdomimis muscles are separated, exposing prevesical fat.

62-3. *The inferior bladder wall and prostate are carefully exposed.* The self-retaining retractor provides adequate exposure.

62-4. *The major arterial blood supply of the right prostate is ligated;* an aneurysm needle carries the ligature. A sponge on a ring forceps assists in providing appropriate traction.



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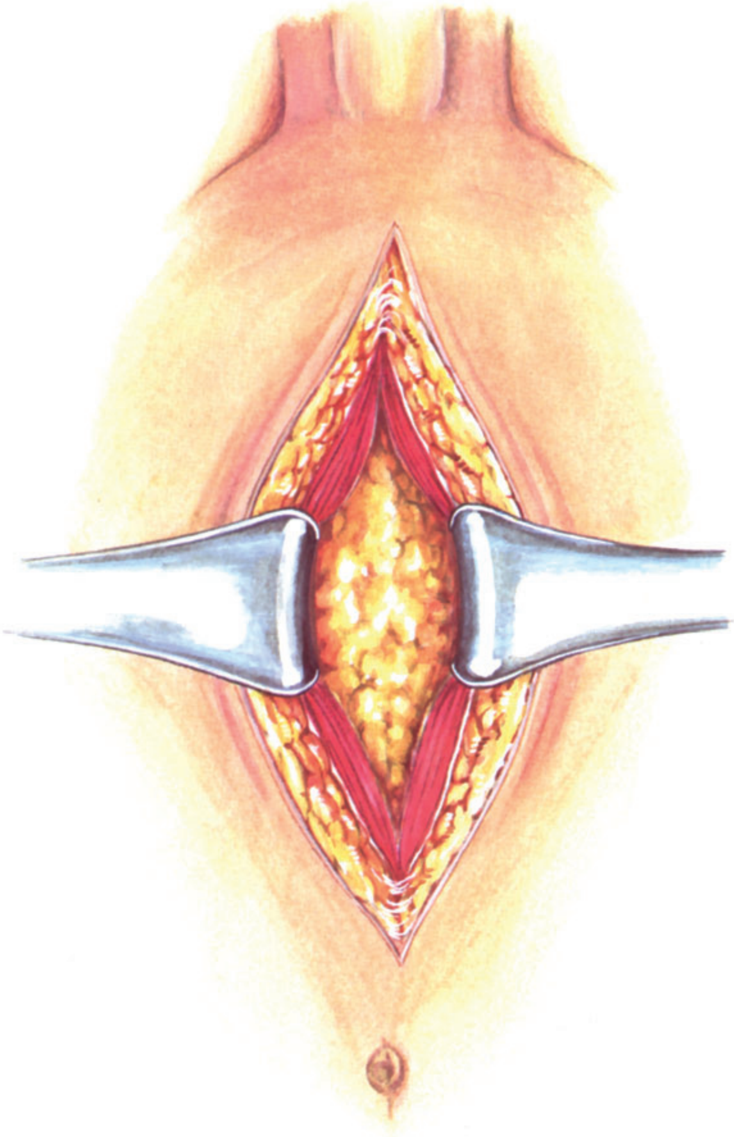

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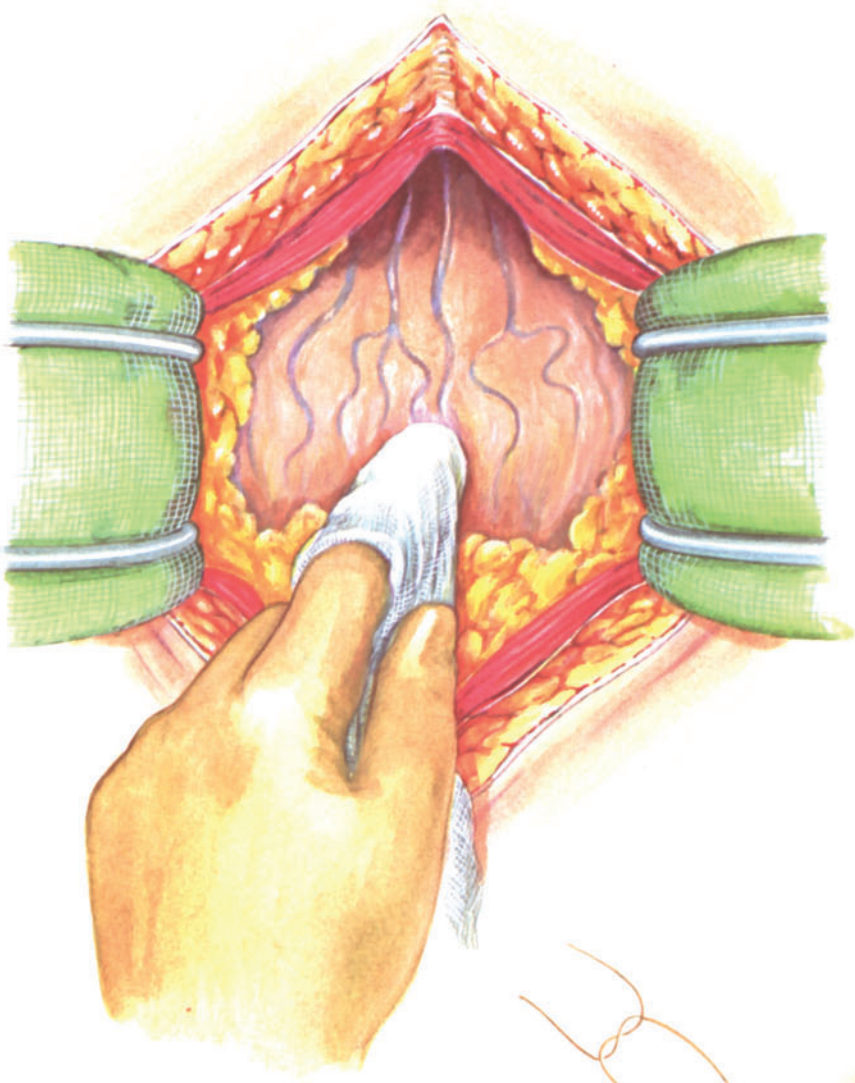

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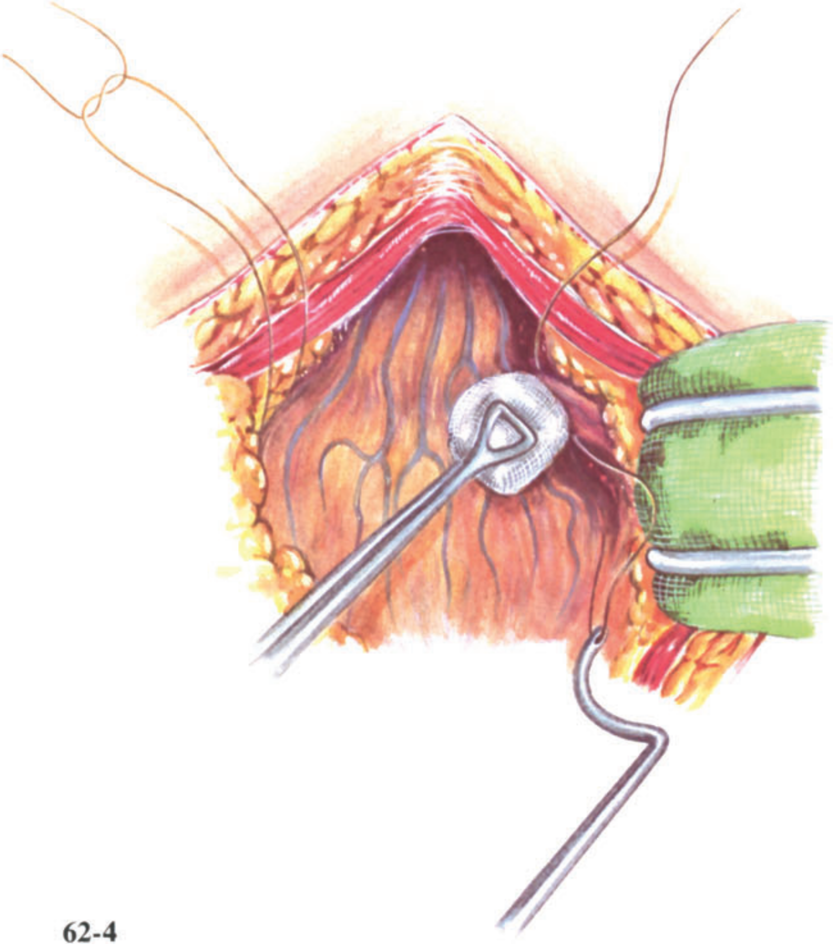


62-4

62-5. *A vertical midline incision is made from the prostate to the bladder neck* by means of a Bovie cutting current. The capsular vein is ligated on each end to prevent excessive bleeding.

The classic capsular incision for retropubic prostatectomy is made in a transverse direction.[4] If this alternative is chosen, then suture ligatures (three for the inferior plane and three for the superior plane) must be placed prior to making the horizontal incision. We have used both capsular incisions with equal success.

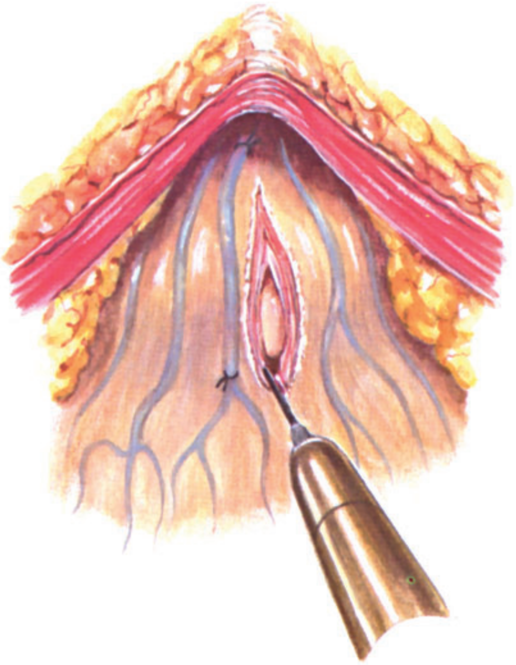
Enucleation of Prostatic Adenoma and Wedge Resection of Posterior Bladder Neck

62-6. *The cleavage plane is established* by using blunt and sharp dissection. The adenoma is freed.

62-7. *The adenoma is detached from the prostatic fossa* near the external sphincter. Care must be taken not to injure the sphincter, either by sharp dissection or by vigorous dissection with the finger in an inferior direction.

62-8. *The posterior bladder neck is grasped at 6 o'clock by an Allis clamp.* The right posterior neck is severed.

62-9. *The posterior bladder neck is excised.* Figure-of-eight sutures (2-0 chromic catgut) are placed at 5 and 7 o'clock for hemostasis. The bladder mucosa is attached to the prostate floor with several 3-0 chromic catgut sutures. The indwelling catheter (22 French) is placed, and the balloon is tested.



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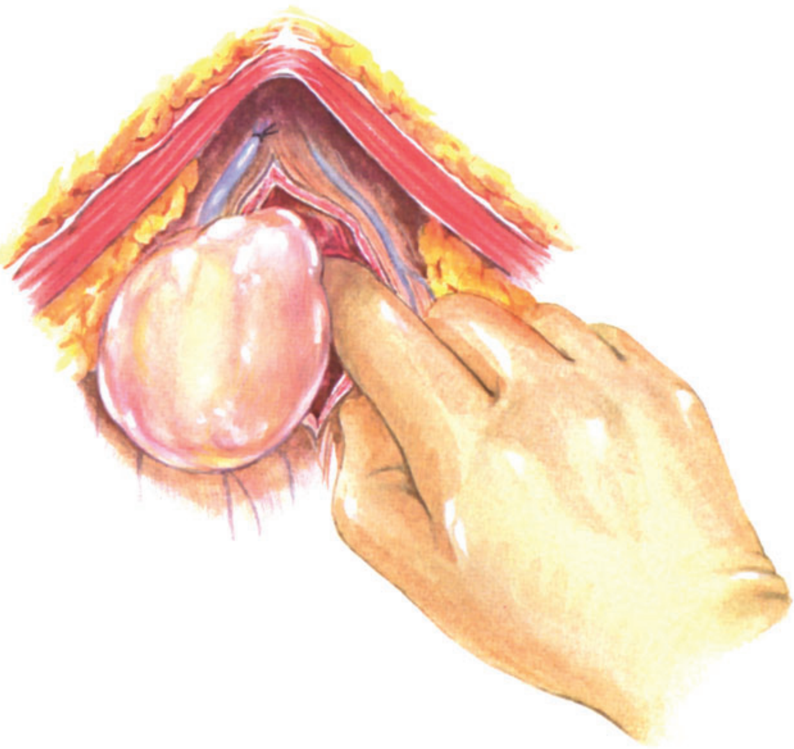

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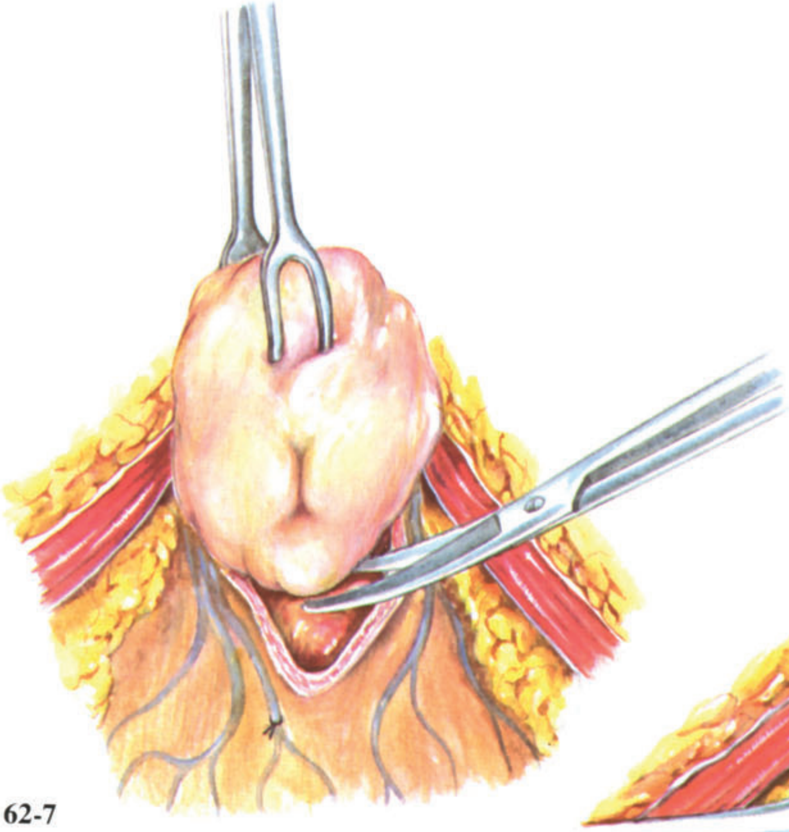

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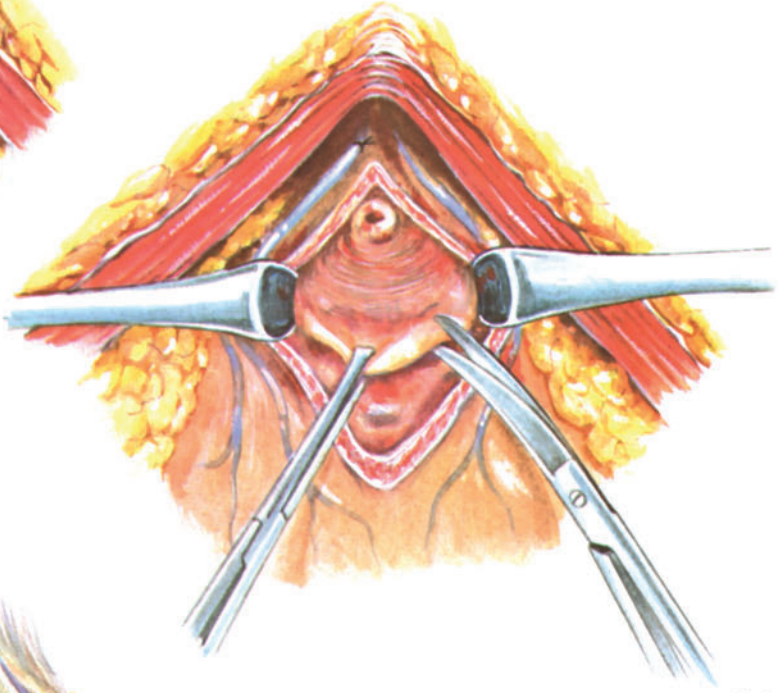

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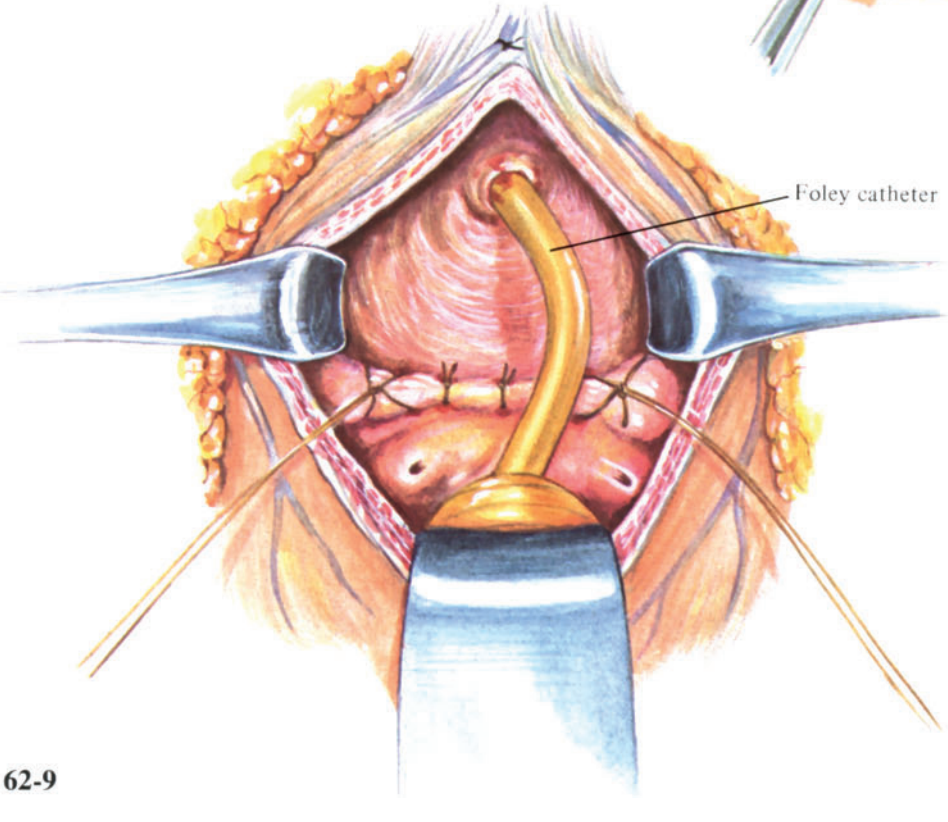


62-9

Closure

62-10. *The prostatic capsule and bladder neck are reapproximated* with 2-0 chromic catgut. One or two Penrose drains are inserted on the lateral aspect of the prostate.

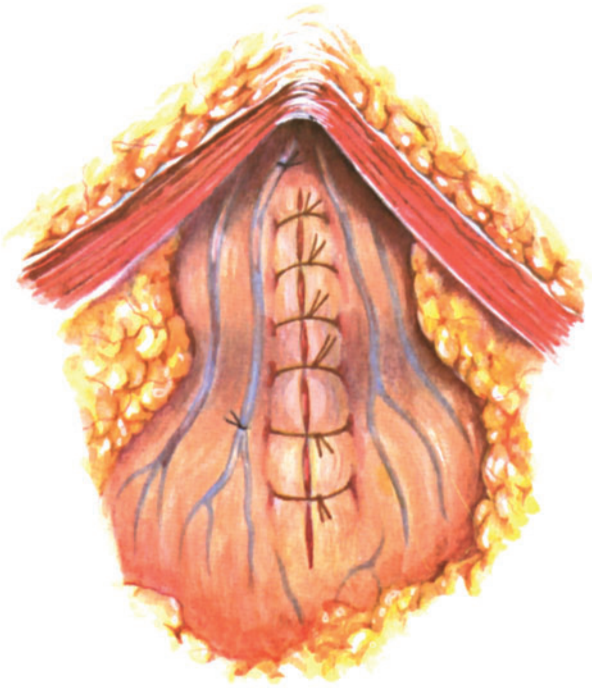
62-11. The indwelling catheter (22 French) is tested again. Thirty milliliters of saline is used to inflate the balloon. The fascia is reapproximated with interrupted sutures (0 chromic catgut). The skin is closed with 4-0 nylon sutures. Although *the Penrose drains emerge from the inferior portion of the incision,* we often make a separate skin stab for each Penrose drain.

63. Radical Retropubic Prostatectomy

The indications for radical retropubic prostatectomy are the same as those cited for radical perineal prostatectomy later in this chapter. Before embarking on the procedure, the surgeon must obtain a positive biopsy for prostatic adenocarcinoma. The extent of tumor is still confined within one lobe and does not involve prostatic capsule.

The major advantage of this approach to the prostate is the fact that bilateral pelvic lymphadenectomy can be performed prior to prostatectomy. However, if frozen sections indicate that the lymph nodes are positive, we do not perform radical prostatectomy. If tumor involves the prostatic capsule and rectum, the patient is treated with megavoltage irradiation.

It is our view that the operation for radical retropubic prostatectomy is less difficult than radical perineal prostatectomy. It is more time-consuming, however, and also results in a larger loss of blood during the dissection. We believe that all candidates for this procedure should undergo sterilization of the large bowel since a proctotomy is a definite possibility. We do not believe that the symphysis pubis needs to be wedged out to allow greater prostatic exposure in most cases.



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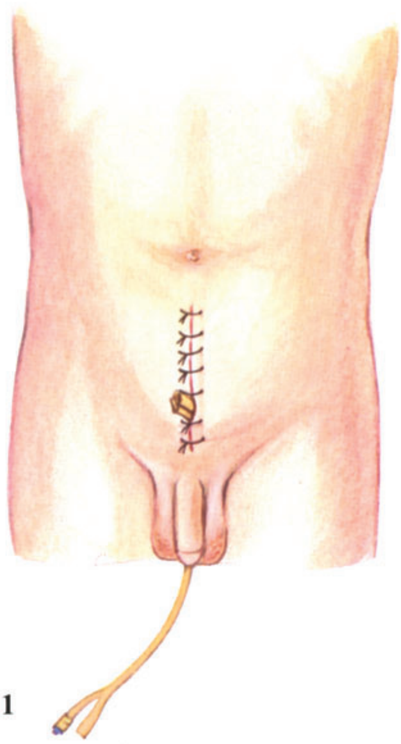
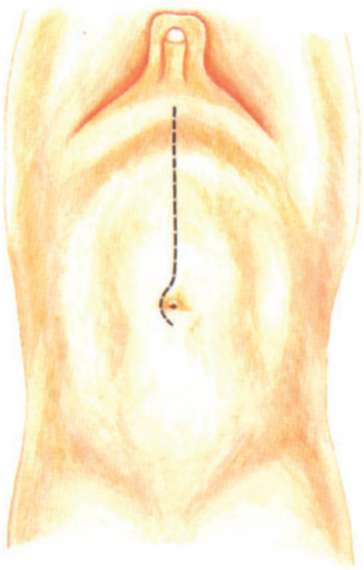


62-11

Positioning the patient appropriately is important in this procedure. The patient is placed in a slight Trendelenburg position with a sandbag or padding beneath the sacrum for support. The lower extremities are horizontal, thus hyperextending the retropubic area. Both legs are separated or abducted to permit access to the penis and rectum. A urethral indwelling catheter is introduced at the start (20 French, 5-ml bag).



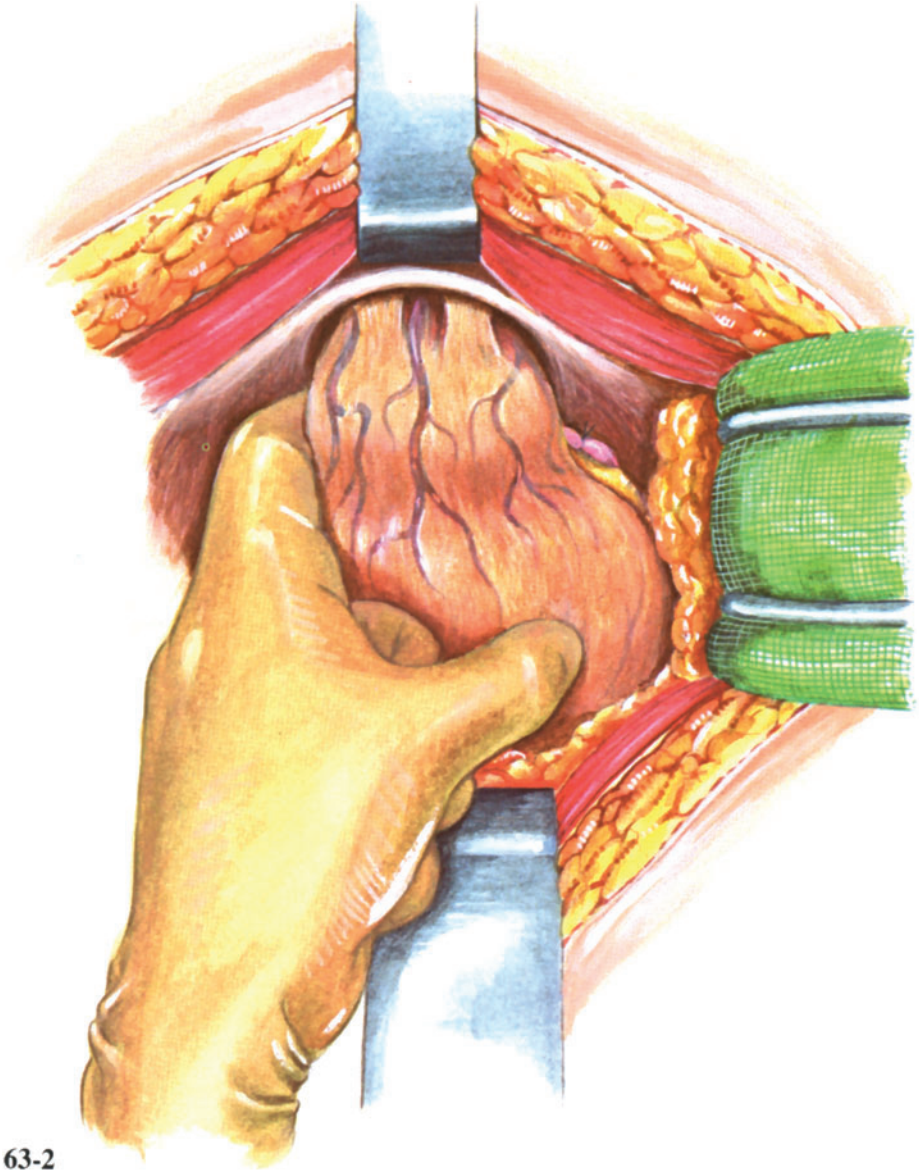
63-1

63-1. *A vertical midline incision is extended* from slightly above the umbilicus to the symphysis pubis. The fascia is opened, and the rectus abdominis muscles are separated. The prevesical adipose tissue and transversalis fascia are dissected superiorly. Any veins encountered superficially are doubly ligated and divided.

Pelvic lymph node dissection is performed bilaterally at this point (see Figs. 65-2 and 65-3 for the procedure).

Surgical Management—Dorsal Vein and Santorini's Plexus

63-2. One enters the endopelvic fascia using a scissors near the pelvic sidewall, away from the prostate and bladder neck region. The lateral venous plexuses can thus be avoided.



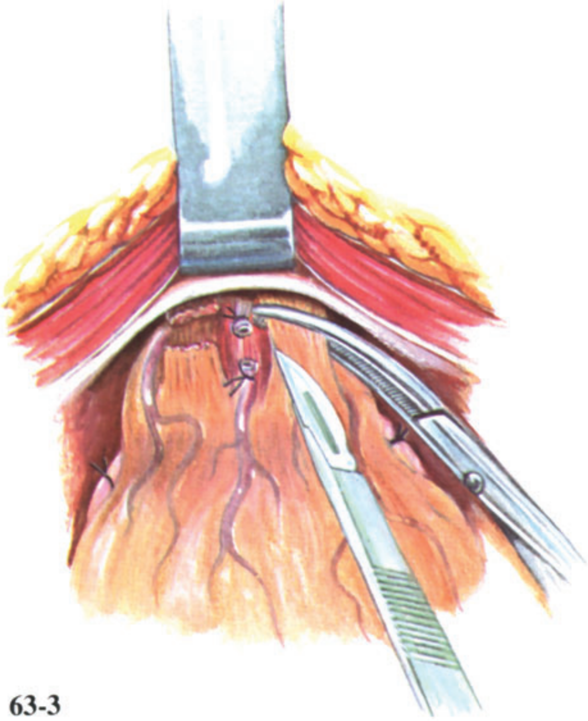
63-2

63-3. Next transect both puboprostatic ligaments close to their attachments to the periosteum of pubis anteriorly. You can thus prevent tearing or lacerating the superficial venous branch.

The superficial branch of the dorsal vein is readily seen in midline and over the bladder neck. The dissection continues inferiorly, exposing the trifurcation of dorsal vein over the prostatourethral junction. The superficial vein is doubly ligated and transected in between.

Now the lateral wall of urethra distal to the prostate can be identified by palpating the urethra with the catheter on the inside. A curved clamp effects a cleavage plane between anterior urethral surface and posterior surface of the dorsal vein network. The dorsal vein complex is doubly ligated, allowing transection of this vein on the bladder side.

63-4. The dissection below the dorsal vein complex is completed, exposing the urethra between prostate and urogenital diaphragm. *The posterior urethral surface is dissected and the urethra is now transected,* also dividing the catheter in this location.



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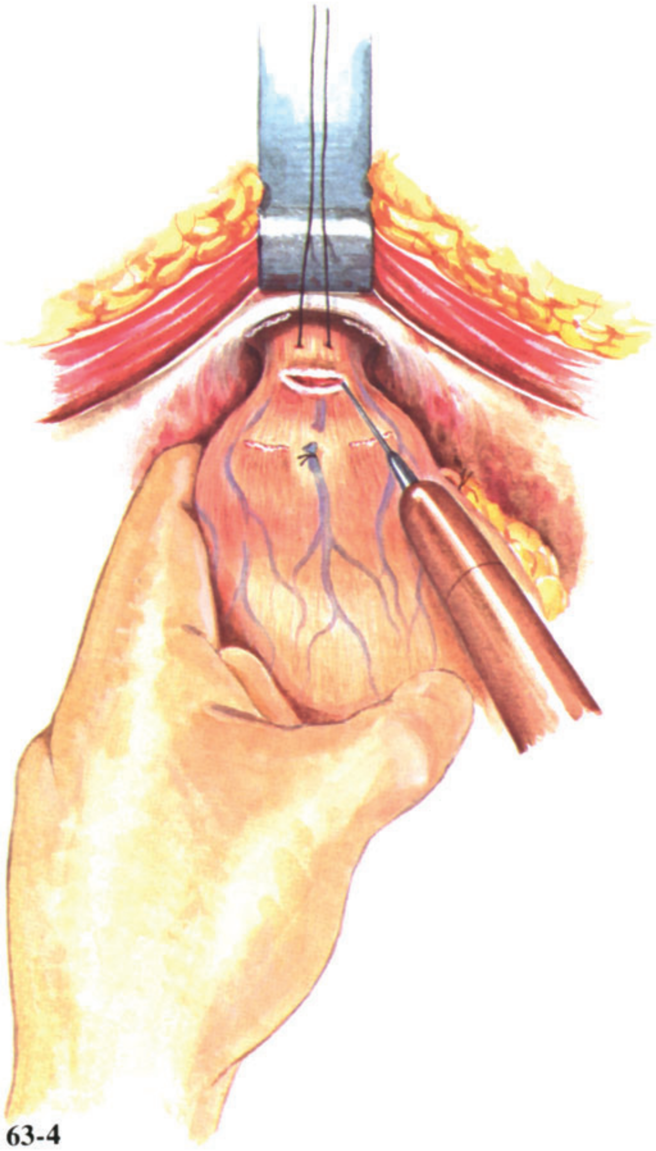


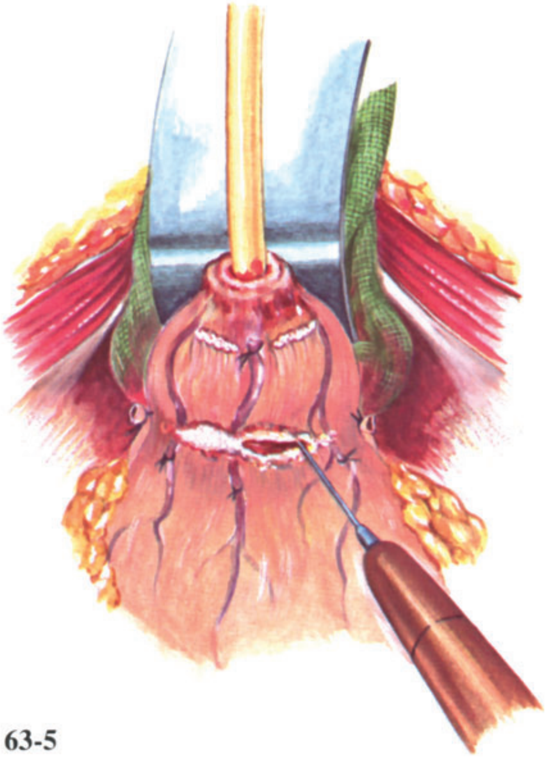
63-4

Careful placement of a curved or blunt right-angled clamp around the urethra at the prostatomembranous urethral junction is helpful at times. If the malignant area is not at the apex, then a small segment of prostatic capsule can be left behind at the time of incision.

63-5. The anterior half of prostatourethral junction is incised, and the catheter is now brought out of the wound as a loop. The end of the catheter connected to the inflated balloon is clamped and used for traction. The distal half of the catheter, which has been divided, is removed at the penile tip. Now *the remaining posterior half of the urethra is divided,* with a curved instrument if necessary to protect the rectum. Lifting the catheter and prostate superiorly assists in exposure of the urethra. The bladder wall on its anterior surface superior to bladder neck is incised transversely with the cutting current.

At times, bleeding from the distal end of the membranous urethra may be bothersome if the dorsal vein of the penis has not been ligated. If visualization is poor, then a 22 French Foley catheter can be inserted through the urethral meatus. The balloon can be inflated proximal to the cut urethra, and gentle traction against the membranous urethra will control the ooze.

63-6. Next *separate the posterior prostate and anterior layer of Denonvillier's fascia from the posterior layer of Denonvillier's fascia and rectum* by lifting the catheter and prostate. The line of dissection can be extended to include complete separation from the rectum. Placing the index finger around the sides of the prostate can sometimes assist in finding the proper cleavage plane posteriorly. The area proximal to the bladder neck is also opened to allow dissection of the posterior prostate beyond the seminal vesicles. At times the plane of dissection is adherent. A second glove can be placed over the surgeon's hand, and rectal palpation can assist in find-



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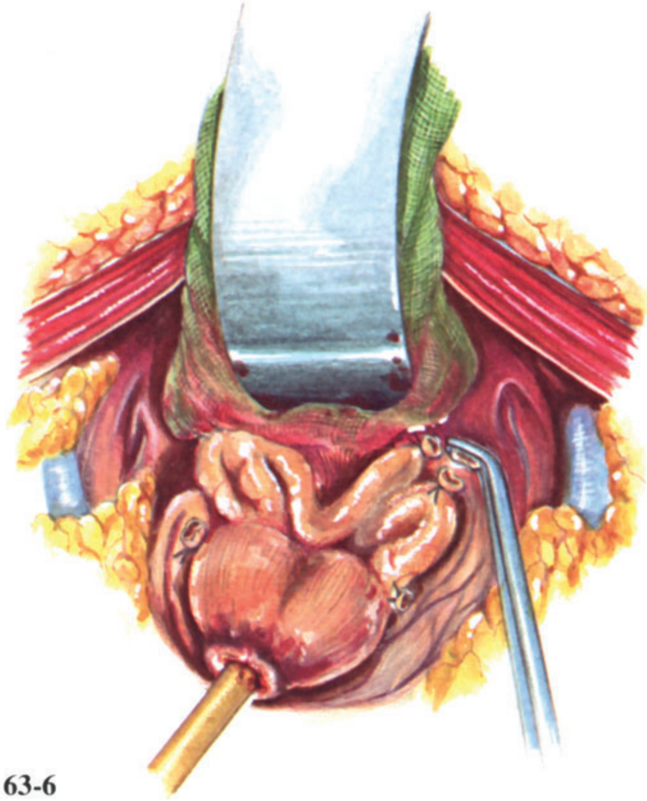


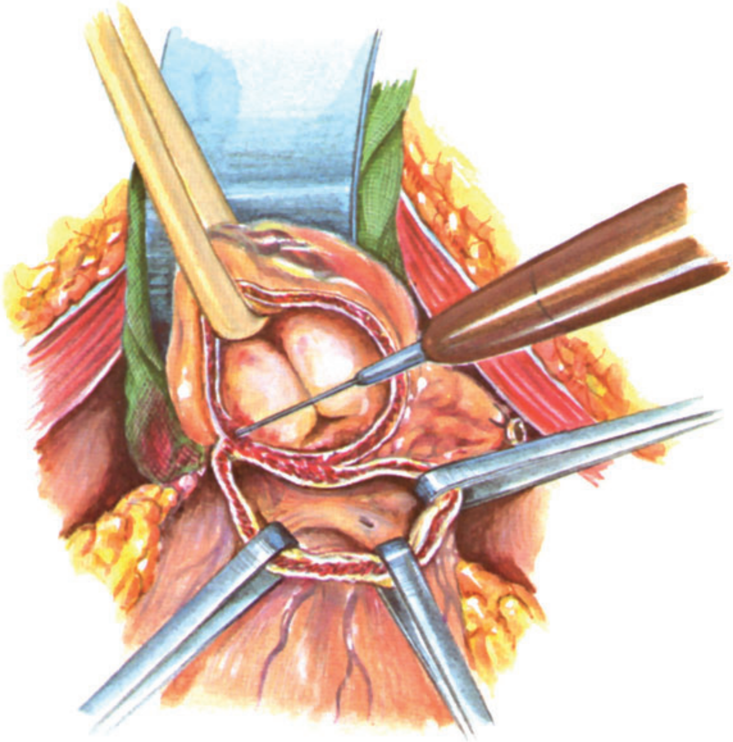
63-6

ing the proper cleavage plane. The prostate and bladder neck, along with the attached seminal vesicles, are lifted, and the posterior prostate is dissected between both layers of Denonvillier's fascia. The dissection begins inferiorly at the urogenital diaphragm and proceeds superiorly. The seminal vesicles and the vas deferens are doubly ligated on each side. The entire seminal vesicle will be removed with the prostate. The rectum will thus be separated from the prostatic capsule, the entire prostate, and the seminal vesicles.

63-7. *The posterior neck is then incised through the bladder neck,* exposing each surface from the anterior side. A Penrose drain is inserted to assist the surgeon in cutting the bladder neck. Each vas deferens has been isolated medially and doubly ligated before being transected in between, from the posterior approach. The entire seminal vesicle on each side is then dissected free by means of blunt and sharp dissection.

The vascular pedicles supplying the prostate can be ligated now if the initial dissection has not provided good exposure at the prostatovesical junction. The pedicles can be found at the capsular angle on each side, near the bladder neck. Lifting the prostate away from one side helps to isolate the pedicle. Each pedicle is doubly clamped, divided, and ligated with 2-0 chromic catgut.

Both sides of the bladder are cut with the electrocurrent angled perpendicularly to the 5–7 o'clock region of bladder proper. Reverse downward and inferior traction on the Penrose drain during the maneuver helps to avoid damage to the ureteral orifices. The ureters may be catheterized if necessary. The specimen is removed.



63-7

64. Vesical–Urethral Anastomosis

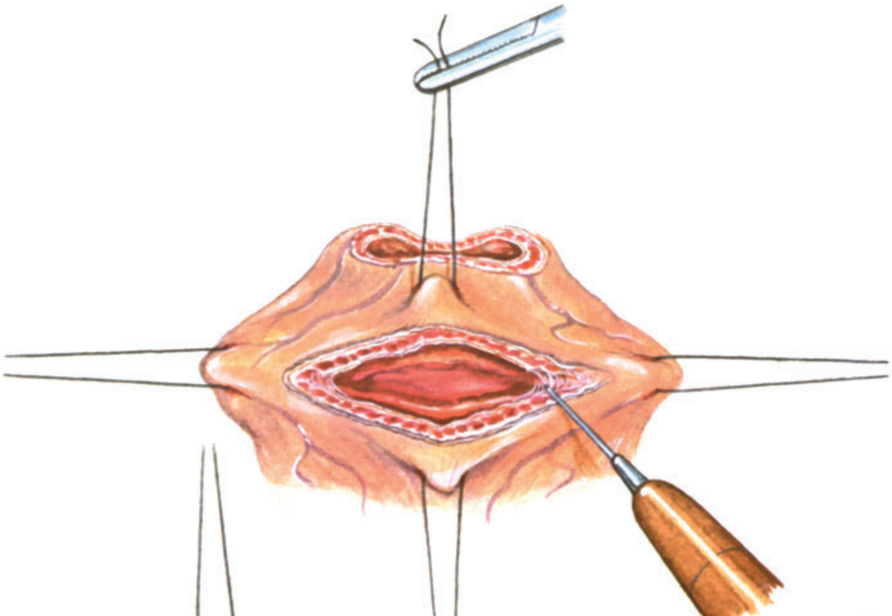
This technique can be used to provide less tension at the future site of anastomosis.

64-1. *A transverse incision in the anterior bladder wall is made.* Stay sutures assist in the orientation.

64-2. *Closure of this incision is in the vertical plane.* Stay sutures help in orienting and facilitating the closure.

64-3. *The bladder neck is narrowed* by closing the posterior bladder wall with interrupted 2-0 chromic catgut sutures. Care must be taken to prevent damage to both ureteral orifices.

Before the vesical urethral anastomosis is begun, hemostatic sutures are placed around the newly formed, widened bladder neck area (2-0 chromic catgut). The new vesical neck must also be narrowed to accommodate the smaller urethral opening.



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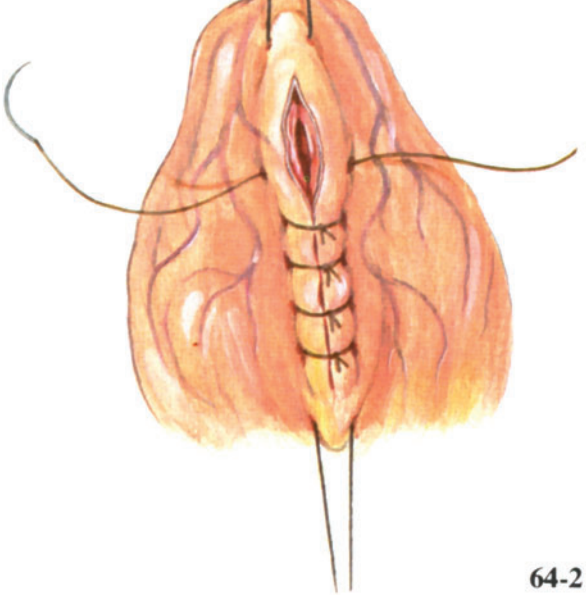

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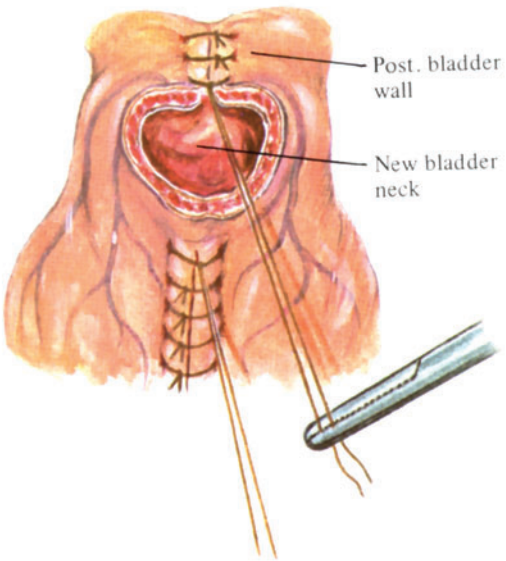

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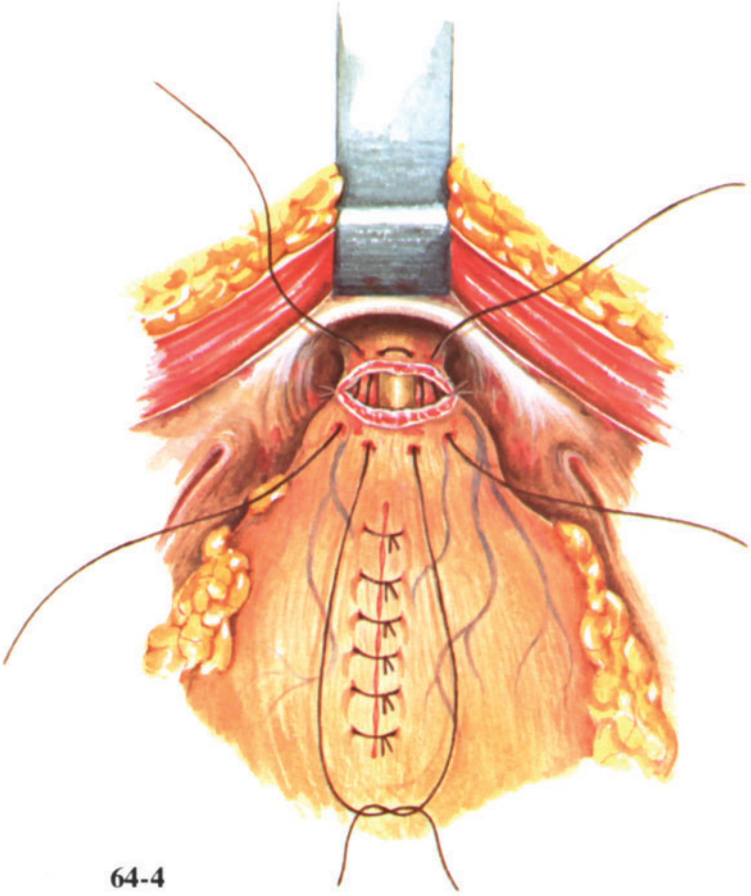
An inverted Y configuration can be used as an alternative method of narrowing the bladder neck. The branches of the Y extend slightly toward the trigone and ureteral orifices. This narrowing allows accommodation of the distal urethra. If a small segment of prostatic capsule at the apex has been preserved, the anastomosis can be made more easily using 2-0 interrupted chromic catgut sutures.

An indwelling 22 French catheter passed per urethra to the transected membranous prostatic urethra helps in the exposure. Lifting the catheter tip exposes the posterior urethra. A suture is placed posteriorly from the capsule through the urethra to the posterior bladder neck. Before this suture is tied, the lateral quadrant sutures should also be placed. Now all 3 sutures can be tied by gently moving the bladder neck toward the distal urethra to minimize any tension.

64-4. The 22 French Foley indwelling catheter with a 30-ml bag is now passed into the bladder lumen. *The anterior urethral bladder sutures are placed and secured.* The catheter bag is inflated. Every attempt to effect a water tight closure is made. Penrose drains are placed on each side of the bladder near the anastomosis through separate skin stab wounds.

Closure of the wound with fascia, and skin reapproximation are carried out in the usual fashion. The indwelling urethral catheter can be doubly secured by placing a 3-0 silk suture through the glans penis and tying this suture around the catheter. Blood loss must be carefully monitored throughout the procedure, and blood replacement must be instituted early during the procedure.



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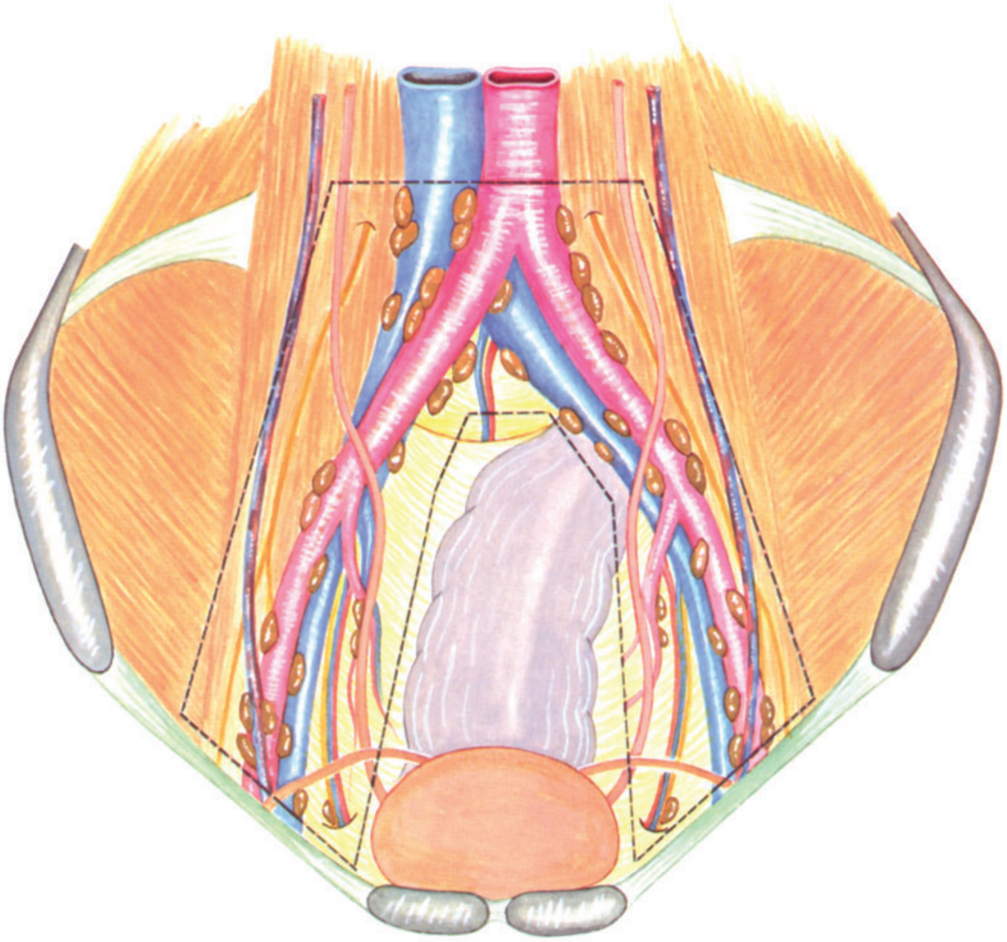
65. Pelvic Lymph Node Dissection

Bilateral pelvic lymph node dissection should be carried out prior to removal of the prostate. This dissection, when performed early, will allow proper staging of the obturator lymph nodes. Examination of frozen sections of the lymph nodes can be made if large matted nodes are encountered.

65-1. *The lymph nodes are to be dissected free of the boundaries* in the schematic (*dotted line*). A meticulous dissection of the pelvic lymph nodes is imperative bilaterally. The dissection includes 1) the common iliac nodes overlying the proximal and distal one-half of the common iliac artery and vein, 2) the nodes extending superiorly to the aorta at the bifurcation, 3) the external iliac nodes, which are adjacent to the entire course of the external iliac artery and vein, and 4) the nodes along the obturator nerve and canal. This dissection includes all fat, nodal tissue, and areolar tissue between the hypogastric artery and its ramifications medially. The pelvic side wall laterally is also included, next to the hypogastric vessels.



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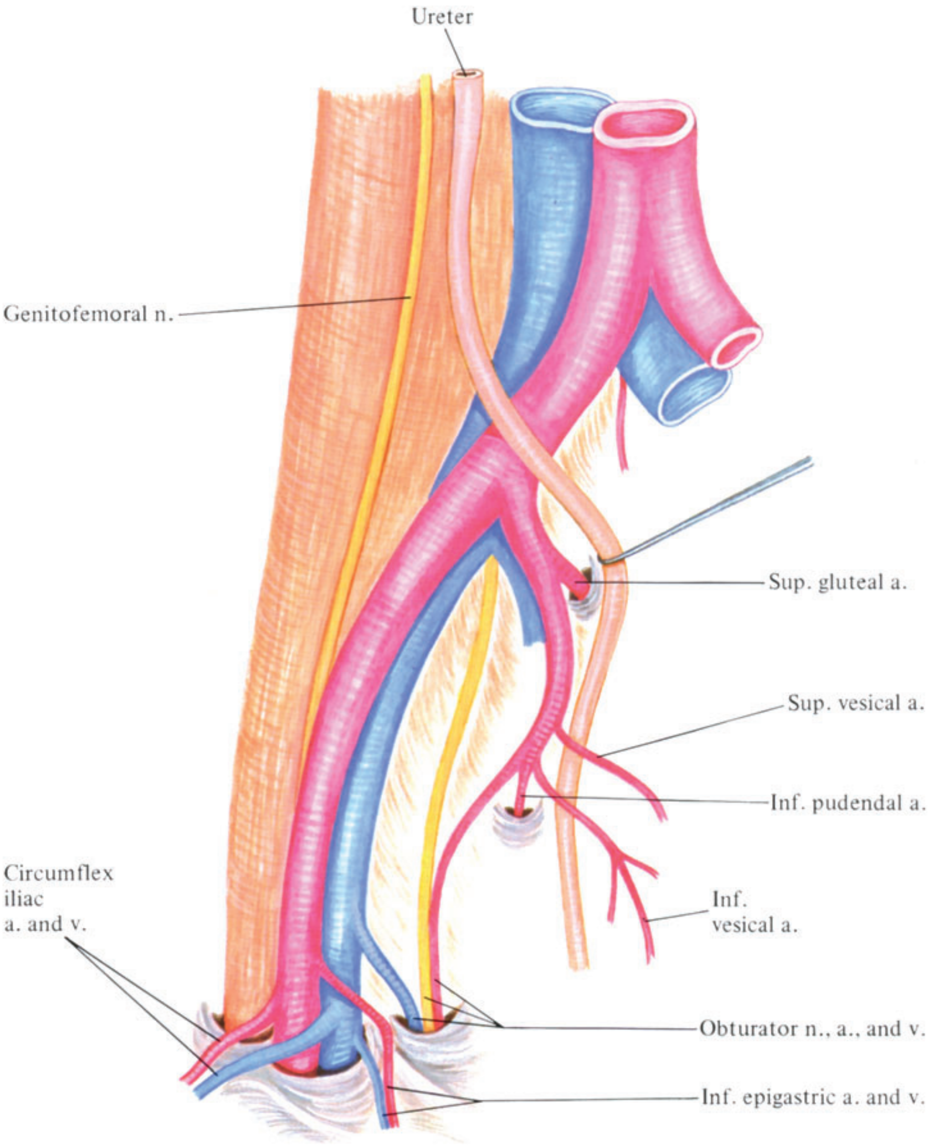
65-2. *The lymph node dissection is completed on the right side in the schematic.*

65-3. The *nodes along the right external iliac artery and vein,* the *right internal iliac artery, and the ureter are visible* prior to dissection.

65-4. In the nearly completed dissection on the right, *the ureter is retracted medially by a Penrose drain.* A vein retractor lifts the iliac vein laterally. A single node remains at the obturator canal. This node is removed.



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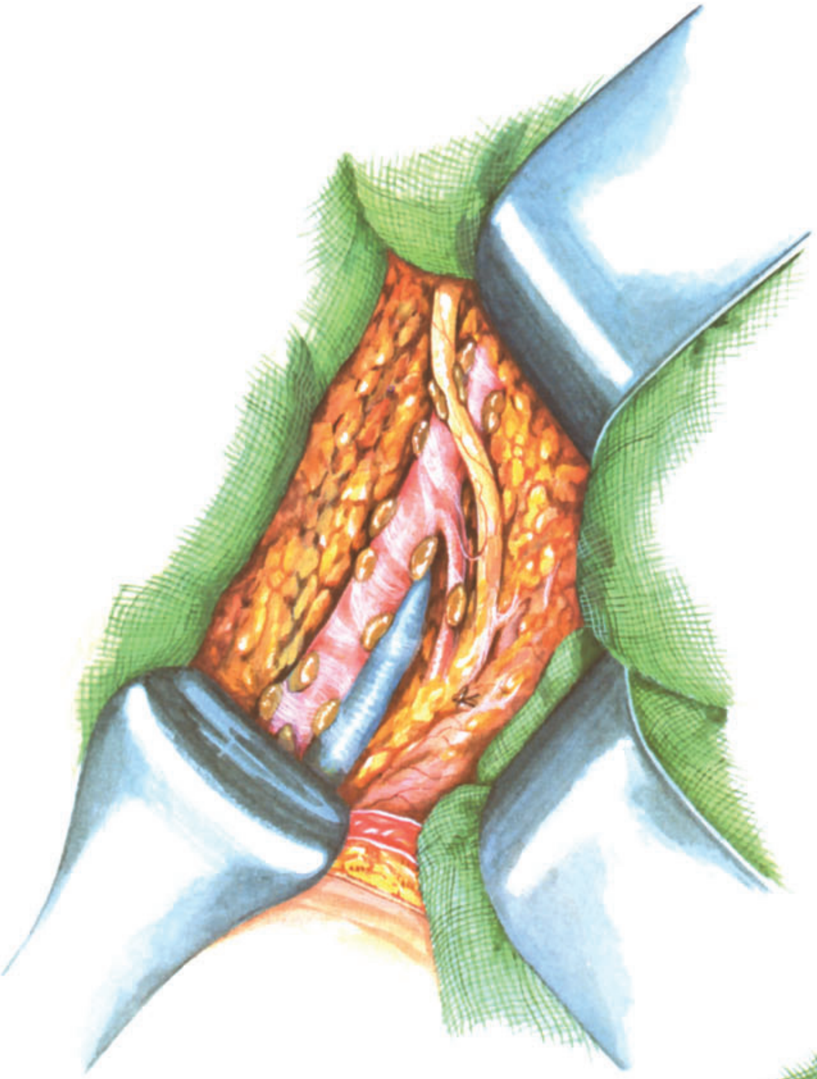

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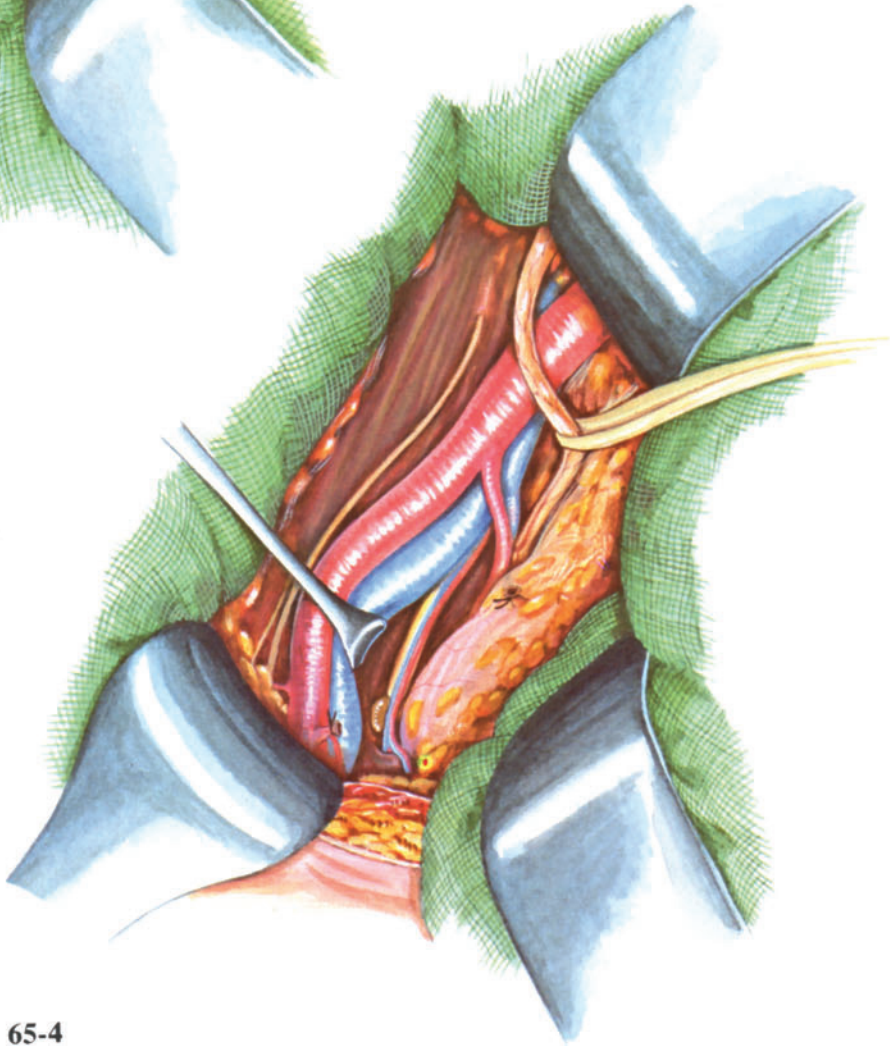

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66. Radical Perineal Prostatectomy—Belt Approach[1,2]

The indication for radical perineal prostatectomy is early cancer confined to the prostate gland. Subtotal prostatectomy is performed for severe prostatic stone disease associated with fibrosis. Prior to the operation, it is important to perform a biopsy on the suspicious prostatic nodule to prove the diagnosis of cancer, or to have evidence of multifocal prostatic carcinoma after transurethral resection of the prostate. We believe that a single focus of cancer found after examining all the resected fragments of glandular prostatic tissue removed transurethrally represents a "clinical cure," and no further treatment for the prostatic cancer is necessary.

When an open perineal biopsy of a suspicious area is performed, frozen section of the biopsy is indicated. If a positive diagnosis cannot be made, then the patient's incision is closed, and permanent microscopic sections are examined a few days later to confirm the diagnosis. As a secondary surgical procedure, we advocate either performing radical prostatectomy within 7–9 days of previous transurethral surgery, or waiting at least 3 months to allow inflammation to subside.

We suggest bowel preparation with antibiotics and mechanical cleansing procedures to sterilize the rectal area. For large-bowel surgery the patient is hospitalized 72 hours prior to surgery. In selected, well-motivated patients, the preparation can be started at home. For small-bowel surgery the patient is hospitalized 48 hours prior to surgery.

1. A low-residue diet is begun and continued during the preoperative period.
2. Enemas (tap water) are administered once daily until day before surgery, when enemas are given twice a day.
3. As a laxative, 16 ml aqueous solution of sodium phosphate (Phospho-Soda) is given twice daily throughout the preoperative period.
4. Oral neomycin (500 mg) and tetracycline (250 mg) are administered four times a day until surgery. An alternative antibiotic protocol includes 1 g neomycin and 1 g erythromycin base, which are given three times on the day prior to surgery. Both medications are given orally at 1300, 1400, and 2300 the day before surgery.

In our experience, tumor involvement of the prostatic capsule (stage C) may be unsuspected, and the rectal wall, including Denonvillier's fascia, may be surgically thinned inadvertently. A proctotomy can be surgically repaired because there has been previous bowel sterilization. The rectal wall is closed in three layers using 3-0 chromic catgut sutures.

We are now convinced that approximately 25% of male patients with stage B adenocarcinoma of the prostate may have extension of tumor to the lymph nodes along the obturator canal. Therefore, we advocate bilateral pelvic lymphadenectomy as a staging procedure before total perineal prostatectomy is attempted.

We agree that pedal lymphangiography for demonstrating metastatic lymph node areas may be helpful along the hypogastric artery and external iliac nodes. However, the obturator nodes, the site of initial tumor extension, are not demonstrated by conventional pedal lymphangiography.

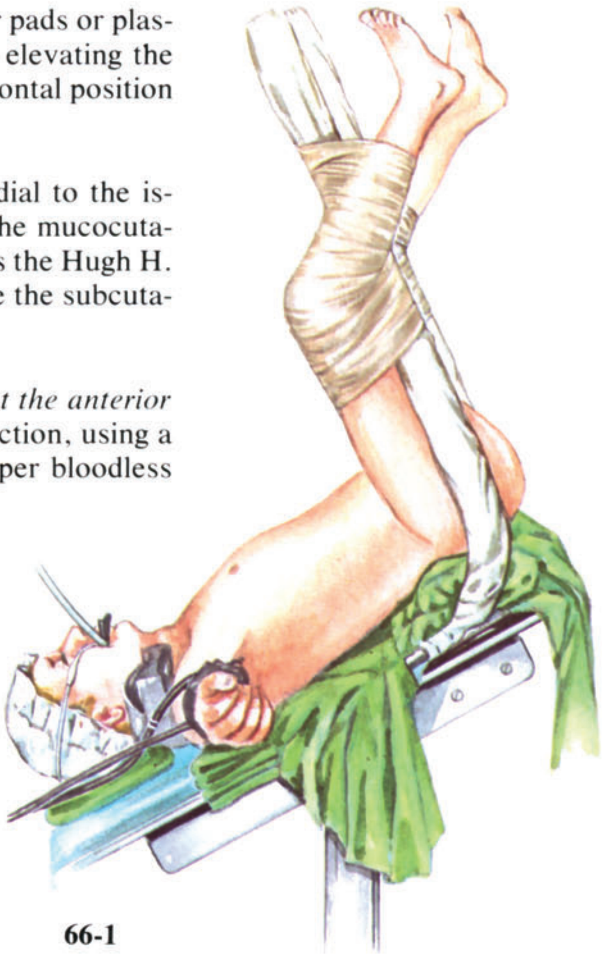
Ultrasound scans of the prostate have not proved beneficial in the past. Ultrasound waves can not discern characteristic patterns between benign nodular hyperplasia and adenocarcinoma. We believe that computerized axial tomography (body scan) of the prostate may be useful for diagnosing early prostatic cancer if particular attention is paid to prior injection of the seminal vesicles and ejaculatory ducts with contrast media. This new diagnostic modality needs to be carefully evaluated.

66-1. *Positioning the patient into an extreme lithotomy posture is important* in this procedure. We like the padded straight poles for elevating the lower extremities. Wrapping both legs from the mid-thigh to the mid-calf area assists in maintaining proper position. The use of shoulder braces is important in maintaining the position. The padded brace should be placed against the bony shoulder prominence. Pressure must be avoided over the brachial plexus.

We have learned that placing several rolls of rectangular pads or plastic-covered sandbags beneath the midsacrum also assists in elevating the perineum into an optimal position. The perineum is in a horizontal position if the patient has been properly positioned.

66-2. *An inverted U-shaped incision is made,* starting medial to the ischial tuberosities and curving anteriorly about 2 cm above the mucocutaneous junction. The second dotted line, larger than the first, is the Hugh H. Young incision line. This incision at the anterior end is above the subcutaneous anal sphincter.

66-3. *The subcutaneous tissue and fat are incised sharply at the anterior margin.* The anal sphincter is avoided. Gentle downward traction, using a sponge and index finger motion, will usually reveal the proper bloodless



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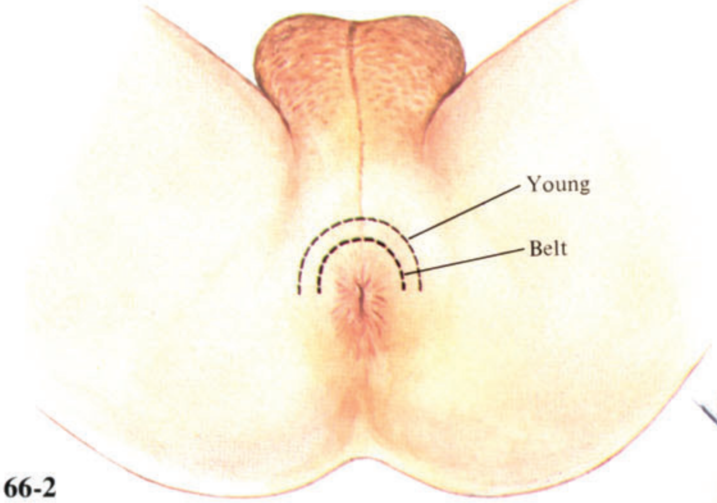

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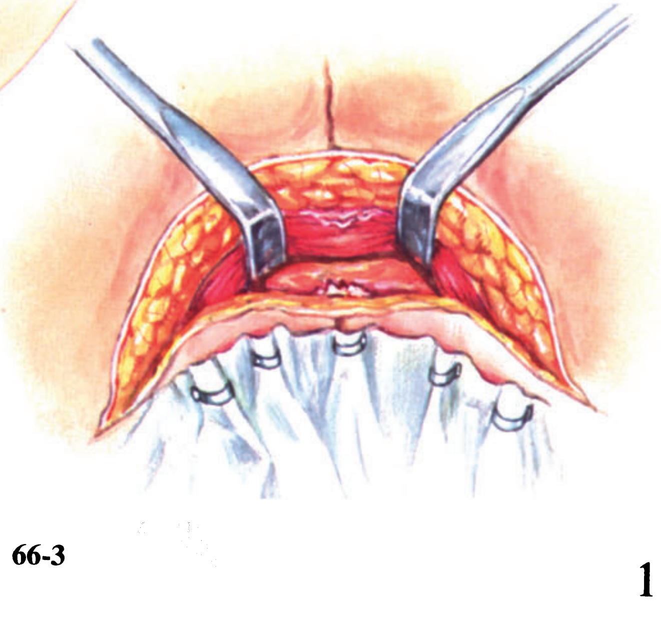
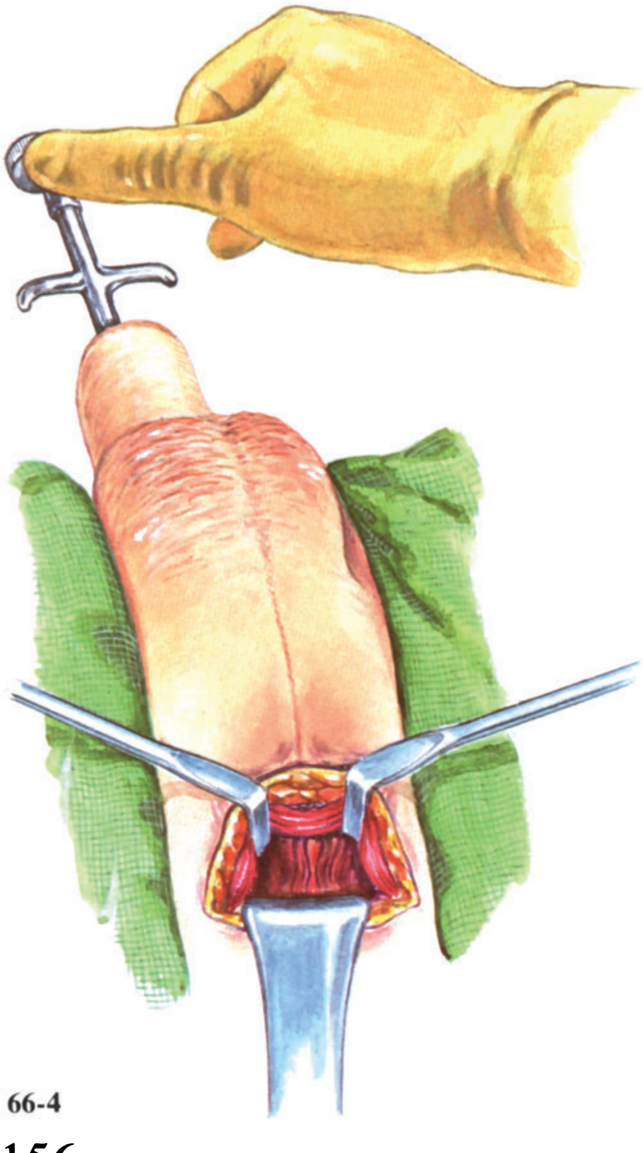


66-3

plane of dissection beneath sphincter. When the external anal sphincter is lifted with the knife handle in one hand, one can move superiorly toward the prostate, with the sponge and index finger of the other hand providing counter-traction against the rectum; the prostate can soon be palpated deep to the levator ani muscles. Superficial lateral paired retractors assist in elevating the anal sphincter.

66-4. *The curved urethral retractor is inserted into the bladder and rotated* to be sure it is in the bladder lumen. Then the blades are opened by clockwise rotation of the knob on the handle. The levator ani muscles are seen, prior to their separation. Superficial lateral retractors are in place at 10 and 2 o'clock. A posterior retractor is in place over a protective sponge and serves also to protect the rectum.

66-5. *Now the prostate can be moved to the wound edge.* Deep lateral retractors are placed in the wound at 10 and 2 o'clock. The levator ani muscles are now separated laterally by blunt dissection, exposing the posterior layer of Denonvillier's fascia. The posterior perineal retractor is replaced over a sponge, which protects the outer rectal wall.



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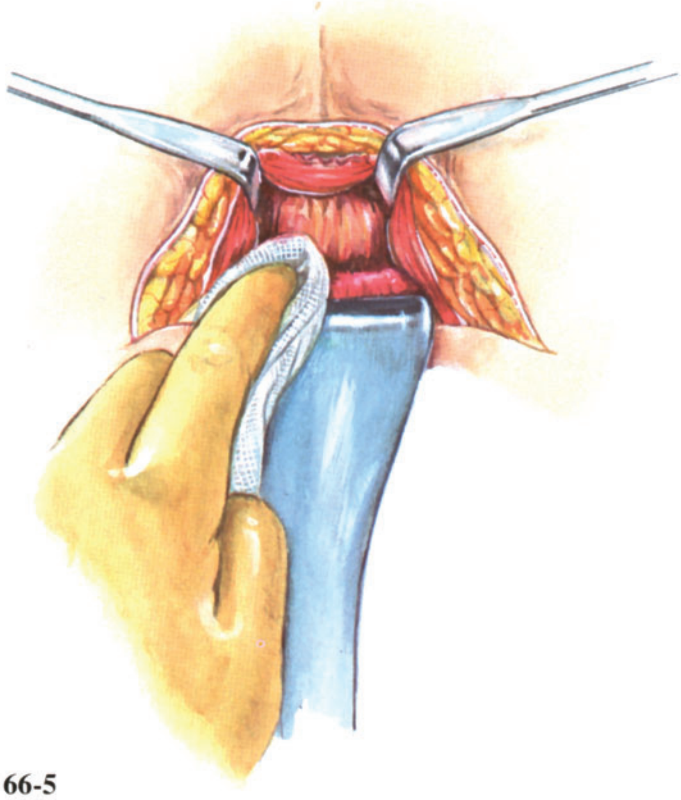

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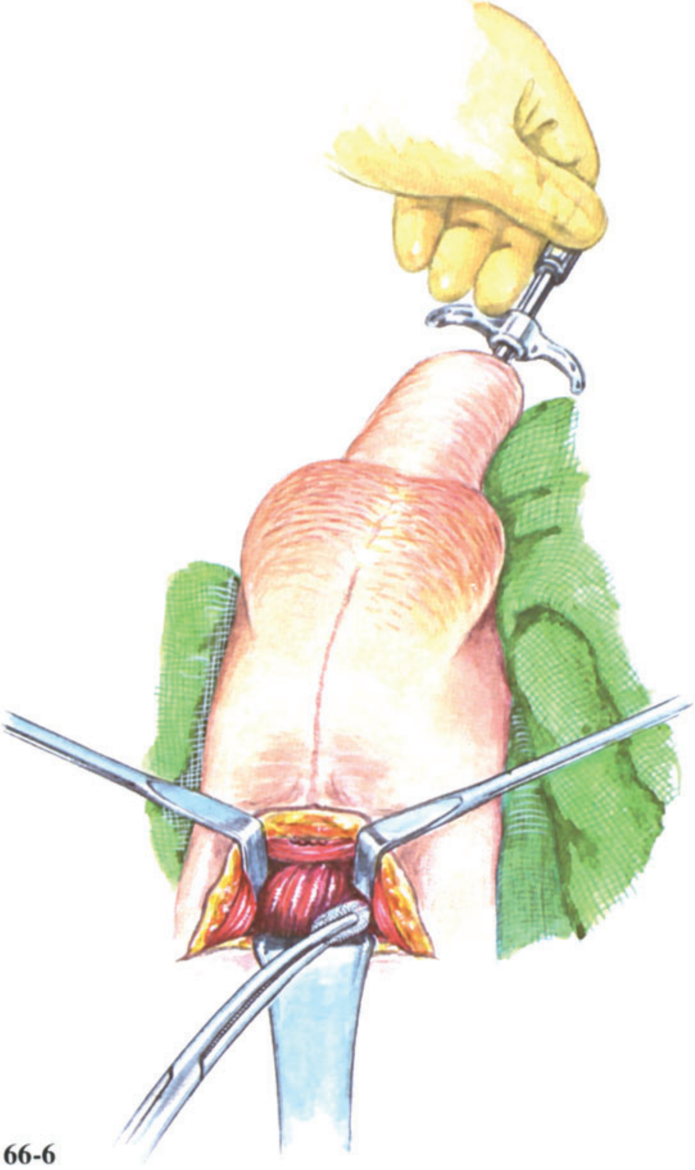

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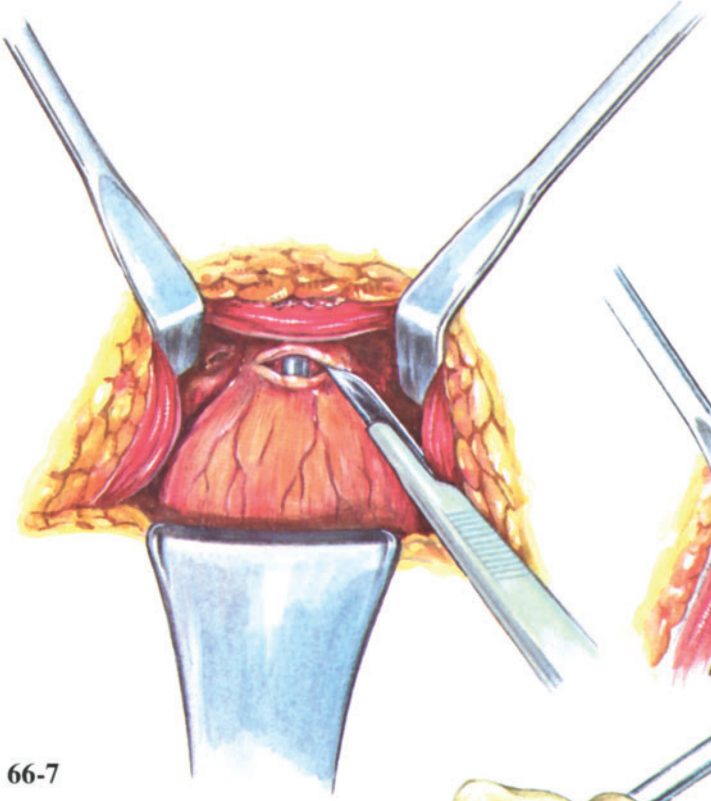
The rectal wall can be separated from the prostate if the proper cleavage plane has been achieved. The rectum and posterior layer of Denonvillier's fascia are separated from the prostate by lifting the handle of the curved urethral retractor superiorly and separating the rectum posteriorly. A sponge on a ring forceps is used in this maneuver. The dorsal aspect of the prostate can be further exposed, including the fascial layer overlying the seminal vesicles.

66-6. *The lateral aspect of the prostate is now dissected free* by moving the retractor handle sideways, so that the prostate is placed under tension away from the side of dissection. Blunt dissection is possible, using the dissecting sponge on a curved clamp. The same maneuver is now employed for dissecting the opposite lateral aspect of the prostate. Completion of both lateral prostatic capsular dissections exposes the vascular pedicles to the prostate. Each vascular pedicle is exposed and freed by blunt dissection on the lower aspect of the prostate. The vascular pedicles can be doubly clamped, divided, and ligated, or the ligation can be done later (66-8). Unlike the radical retropubic approach to total prostatectomy, total perineal prostatectomy avoids the lateral plexus of deep pelvic veins.

66-7. *The soft spot (verumontanum) can be located by palpation.* This landmark enables the surgeon to locate the border at the posterior apex of the prostate, where the membranous urethra begins. The border between the distal membranous urethra and the prostate is incised circumferentially for 180°, exposing the curved urethral retractor. The urethral retractor blades within the bladder are closed, and the instrument is withdrawn carefully. The remaining ventral urethra is transected in a horizontal plane.

66-8. *The straight urethral retractor is inserted perineally into the prostatic urethra and the bladder lumen.* The blades are opened and the entire prostate is lowered, to expose the puboprostatic ligaments. A capsular vein has been ligated. The puboprostatic ligaments are incised away from the prostatic border. The vascular pedicles are now doubly clamped, divided, and ligated on the left. A suture (3-0 chromic catgut) can be used to secure hemostasis.

66-9. *The bladder neck area is now exposed* by placing traction on the prostatic retractor and moving the prostate and attached bladder neck into the wound area. The bladder neck at 12 o'clock is incised with the scalpel or the Bovie knife. An Allis clamp is used to mark the bladder neck on the patient's left at 5 o'clock. The Metzenbaum scissors can be inserted as an alternative. The bladder neck is transected laterally in two separate maneu-



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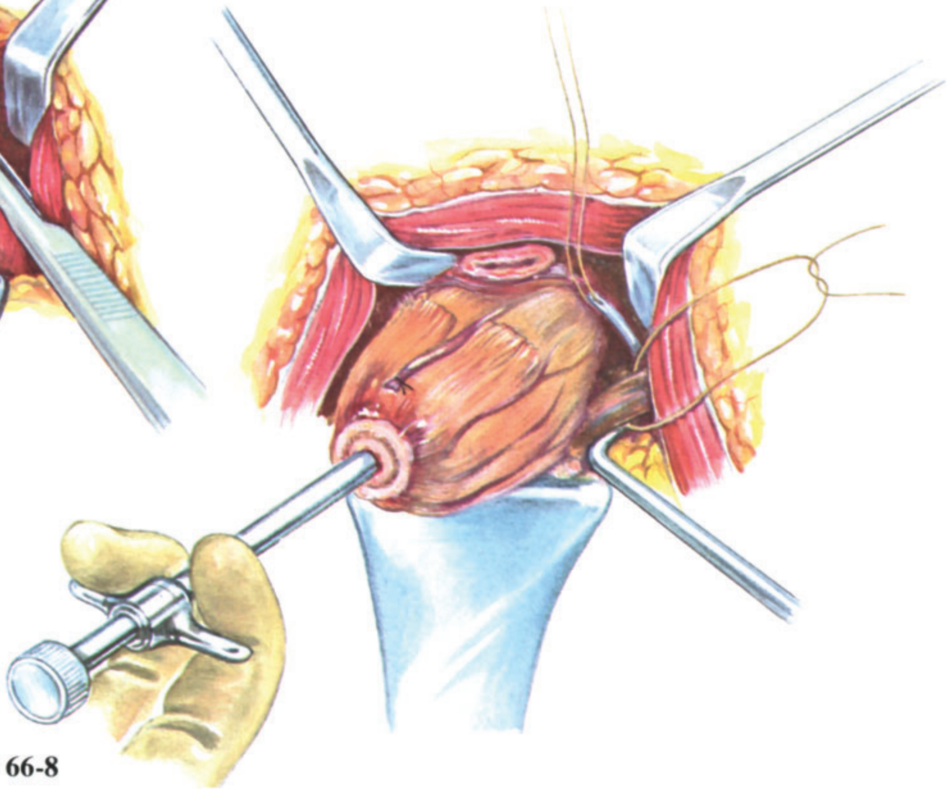
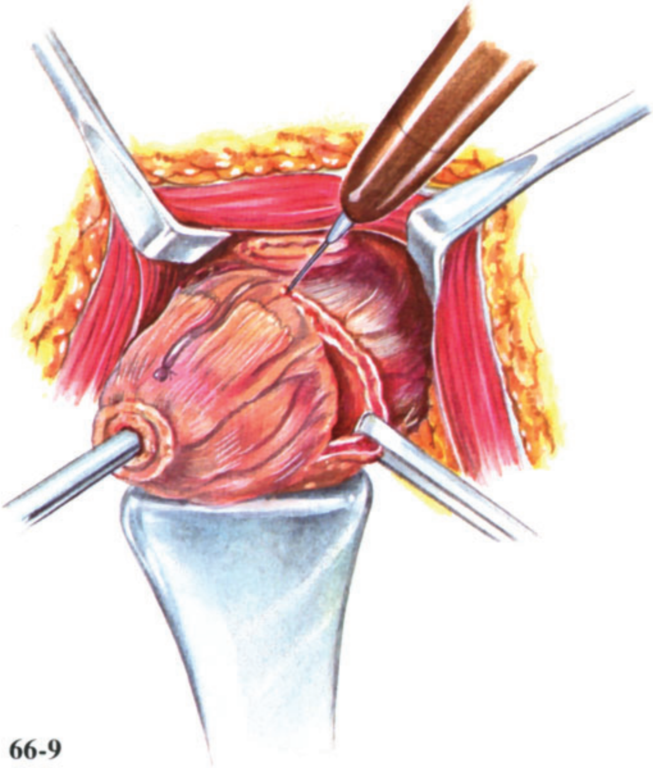


66-8

vers, taking care to keep the blades of the scissors pointed vertically. The danger in cutting bladder neck at 5 and 7 o'clock is angling the scissors towards the trigone and causing injury to the ureteral orifice. A catheter can sometimes be inserted as an alternative to replace the straight urethral retractor, and can be folded over the anterior prostatic border and through the bladder neck to provide traction as well. The deep bladder neck area is incised distal to the trigone and ureteral orifice, leaving at least 1.5–2 cm margin. A scalpel (15 blade) is used to incise the bladder neck at 6 o'clock.

66-10. *Gentle traction on the straight retractor will expose the anterior leaf of fascia covering the ventral surface of the seminal vesicles.* This space is incised and is used to further dissect the seminal vesicles and ejaculatory duct on each side. The entire seminal vesicle with the fascial covering is removed with the prostate. A right-angle clamp is used to free the right seminal vesicle. The ejaculatory duct is doubly ligated and divided on each side after exposure through the anterior leaf of the genital fascia. The ejaculatory duct and accompanying artery lie medial to each seminal vesicle. Sharp dissection now allows removal of the entire prostate, including the capsule and seminal vesicles.



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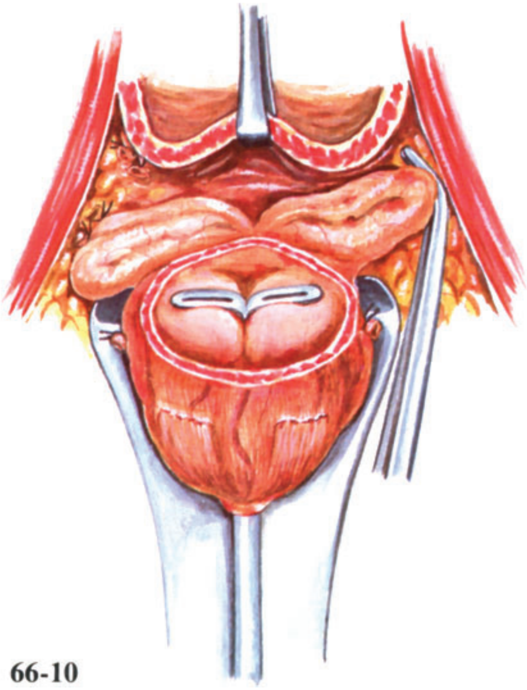

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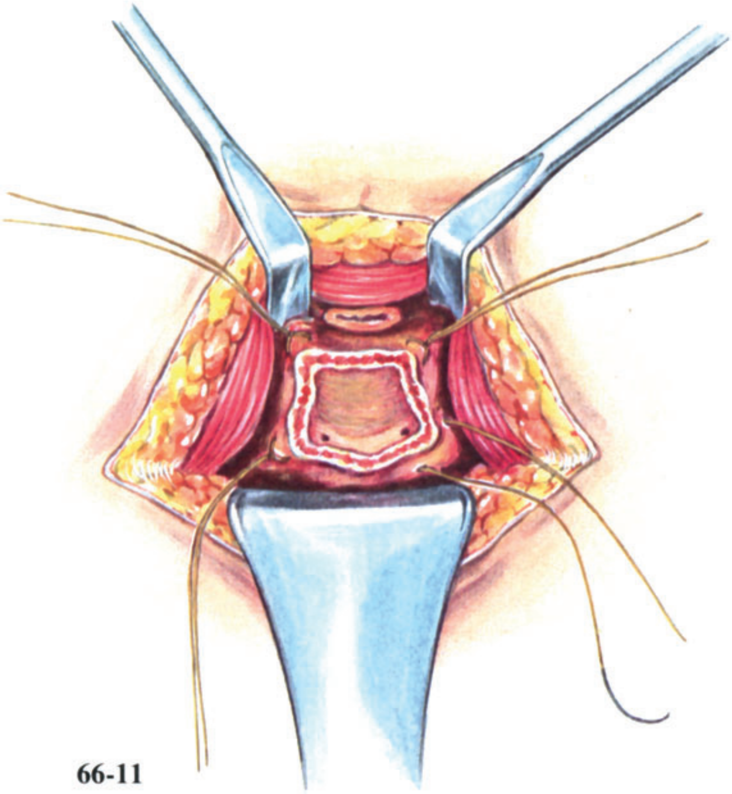
66-11. After the specimen is removed, the bladder neck is identified. Allis clamps are used to grasp the bladder neck at four quadrants. Five milliliters of indigo carmine dye injected intravenously is helpful in the early identification of the ureteral orifices. *Interrupted chromic catgut sutures (2-0) are placed circumferentially to achieve hemostasis.* If the bladder neck is unusually wide, some type of closure must be effected to approximate the size of the membranous distal urethra. We believe that a vertical reapproximation or an inverted Y-shaped closure is effective. The branches of the inverted Y are at 5 and 7 o'clock, further protecting the orifices.

66-12. Before anastomosis of the bladder neck and urethra can be started, a 22 French indwelling catheter with a 30-ml bag is inserted through the urethral meatus. *The catheter tip* reaching the cut membranous urethral end *is pulled through for 7 or 9 cm and raised* (vertically) *superiorly.* A right-angle retractor (or deep lateral retractor) is placed against the catheter at the distal urethral interface and raised anteriorly, exposing the anterior end of the membranous urethra. This most difficult suture is placed horizontally through the urethra. The suture is also placed through the bladder neck at 12 o'clock. This suture is tied, bringing the urethra and bladder neck together.

66-13. The catheter tip is now inserted into the bladder, and *the urethra is sutured to the bladder neck along the remaining quadrants.* Four to six sutures are placed to often obtain a water-tight closure. Excessive bladder neck has been reapproximated, using a vertical closure.

The catheter bag is inflated and tested. Blood clots are removed from the bladder lumen by irrigation.



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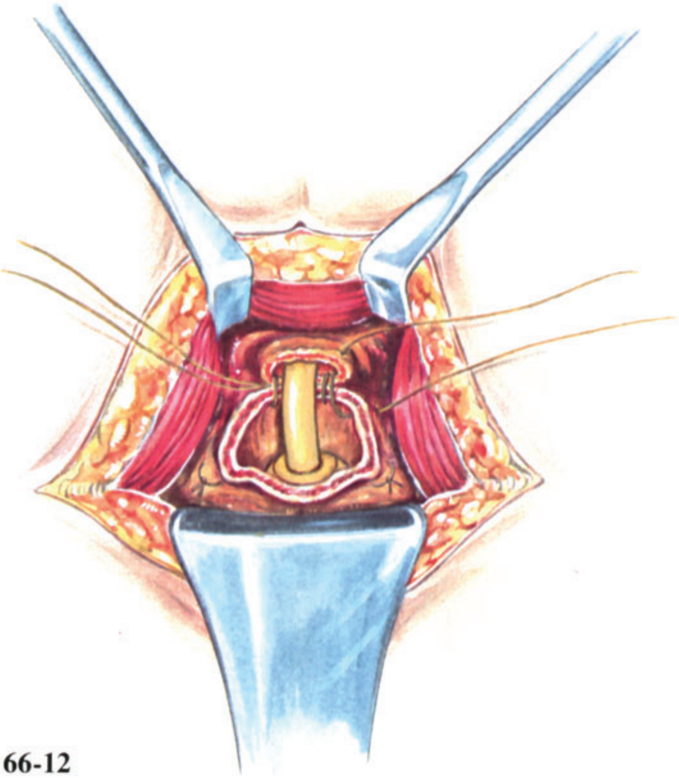

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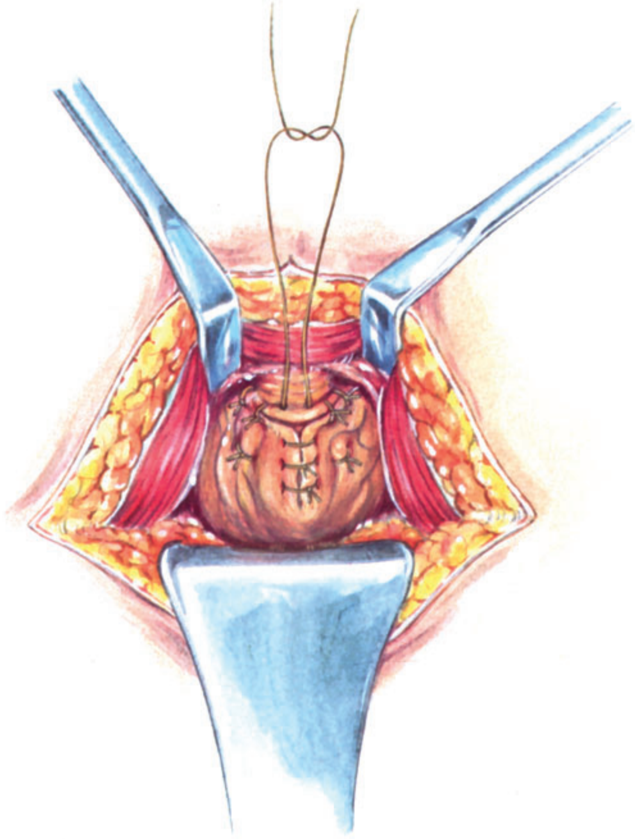

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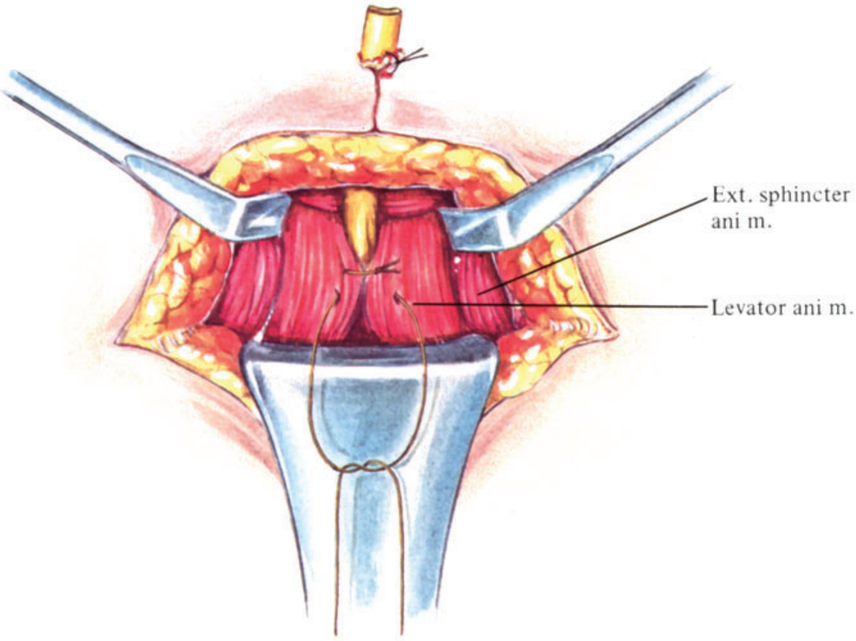
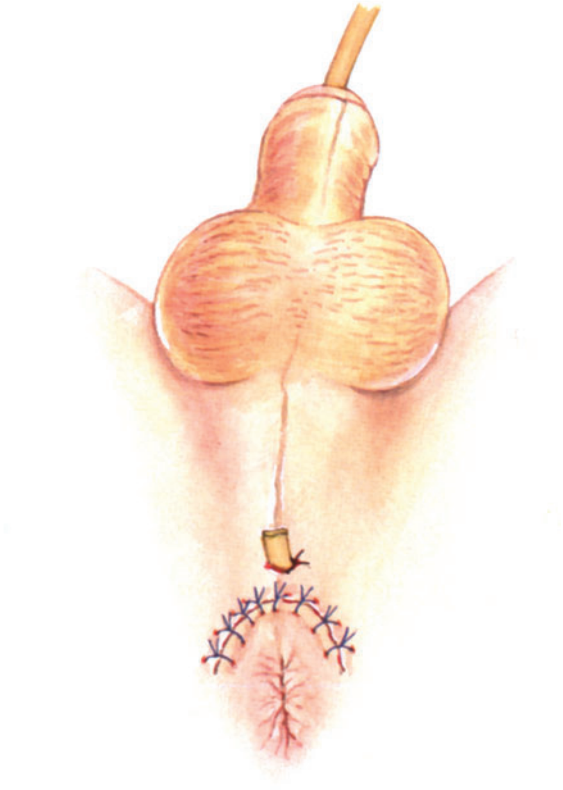


66-14

66-14. *Closure of the wound is now begun.* A drain is brought from the anastomotic site to the skin edge. It is brought out to the skin through a separate stab incision. The levator ani muscles are reapproximated with 2-0 chromic catgut before subcutaneous tissue and skin closure.



66-15

66-15. *The anal sphincter has been protected.* The skin is reapproximated with 3-0 nylon sutures.

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The Urethra

5

Surgical Anatomy

The Male Urethra

The male urethra is a fibroelastic structure that extends from the internal urethral orifice at the vesical neck to the external urethral meatus at the tip of the glans penis. It is divided by the urogenital diaphragm into three parts: prostatic, membranous, and penile (Fig. 1). The prostatic urethra is the widest and is about 3 cm long in normal adults. The lumen of the urethra is distensible but normally is obliterated by elastic fibers causing apposition of its anterior and posterior walls. In prostatic lateral lobe hyperplasia, the urethral wall is changed into a wide anteroposterior fissure by encroachment of the enlarged lateral lobes upon the urethra.

The urethral crest extends along the posterior floor of the urethra from its origin on the vesical trigone to its bifurcated end. The prostatic sinus is a depressed fossa on each side of the crest and has many orifices from prostatic ducts (Fig. 2). The seminal colliculus (verumontanum) is the greatest prominence of the urethral crest, and the prostatic utricle opens in its central surface. The finer slitlike orifices of the ejaculatory ducts open beside prostatic utricle.

The membranous urethra is the shortest, about 1.5 cm long, and passes through the urogenital diaphragm between its superior and inferior layers of fascia. This part of the urethra has no proper surrounding tissue but contains the circular fibers of the deep transverse perineal muscle, called the external urethral sphincter. This is a voluntary muscle controlled by the perineal branch of the internal pudendal nerve.

Behind the membranous urethra, close to the inferior layer of the urogenital diaphragm, lie the bulbourethral glands of Cowper, which open into the penile urethra at its bulbous part on each side.

The penile urethra is the longest segment of urethra and is surrounded by the spongy body. It is about 15 cm long when the penis is flaccid and has a right-angled curve at the penoscrotal junction. The bulbous urethra is dilated and forms the perineal curve; openings of the bulbourethral glands of Cowper lie at its posterior wall. On the floor of the penile urethra are numerous small lacunas and mucous glands, the glands of Littre (Fig. 2). The external meatus is the narrowest part. The preterminal urethra next to the meatus has a dilated lumen known as the fossa navicularis.

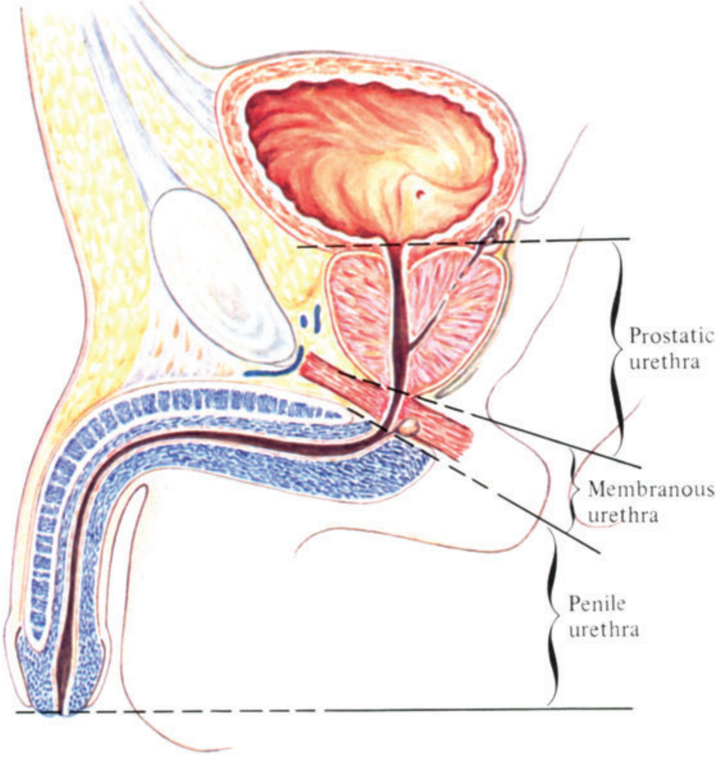


FIG. 1. Anatomy of male urethra, midsagittal section.

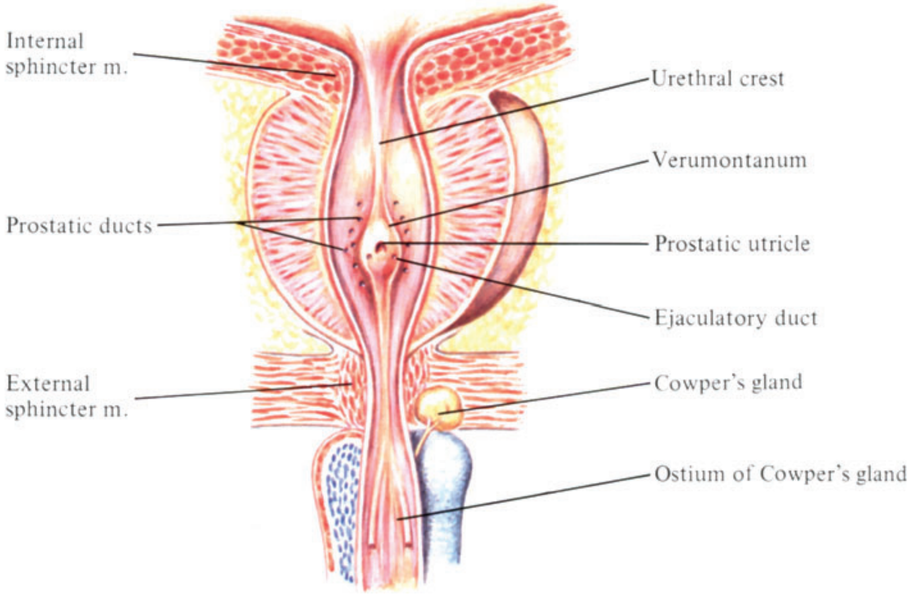


FIG. 2. Prostatic and membranous urethra (anterior half of prostate has been unroofed).

The arterial supply to the urethra is derived from branches of the internal pudendal and inferior vesical arteries. Veins drain into the pudendal or perivesical plexuses. Lymphatic drainage is to the inguinal nodes and lymph glands along the iliac vessels.

The Female Urethra

The female urethra is approximately 4–5 cm long and begins at the internal urethral orifice or vesical neck. It follows a slightly curved course down-

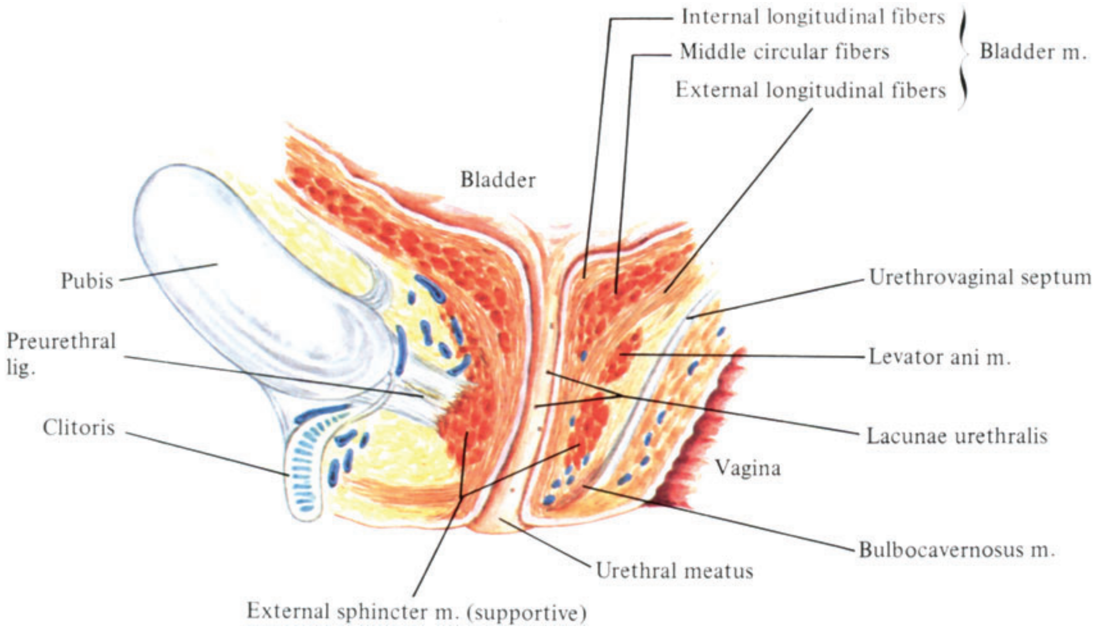


FIG. 3. **Female urethra, midsagittal section.**

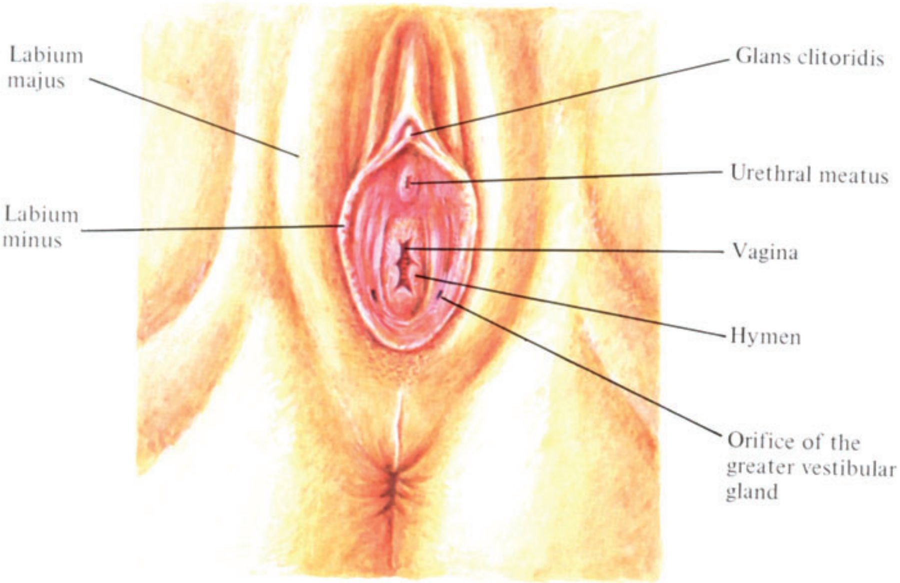


FIG. 4. Female external genitalia.

ward and forward and terminates at the external urethral meatus on the roof of the vestibule.

The epithelium of the female urethra is squamous in its distal portion and transitional in its proximal segment. Numerous periurethral glands are embedded in the submucosal layer; the largest are the glands of Skene, which open just inside the meatus.

The longitudinal smooth-muscle layer of the bladder neck is prolonged to encase the urethra, but at the portion that pierces the urogenital diaphragm, it is surrounded by striated sphincter muscle, as in the male. The urethra also passes through the levator ani muscle before traversing the diaphragm and is supported by bulbocavernous muscle under the diaphragm.

Because the female urethra is short, care must be taken not to damage the urethral wall in operative procedures (Figs. 3 and 4). A distinct sphincter action is not always demonstrable in the female.

Operative Techniques

67. Surgical Repair of the Ruptured Urethra at the Distal Prostatic Junction

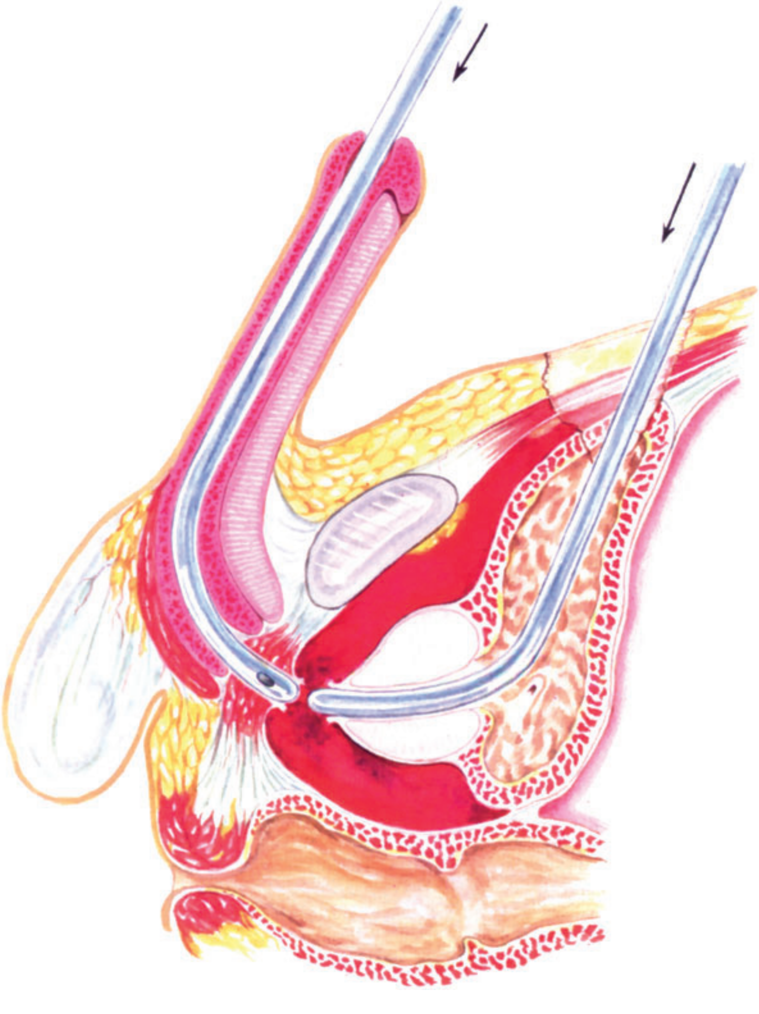
Complete rupture of the distal prostatic urethra is suspected if a male patient has suffered injury to the bony pelvis. The patient may present with fresh bleeding out of the urethral meatus.

The entire patient must be evaluated. The cardiorespiratory system and the central nervous system take priority over the urologic system. Any penetrating wound of the abdomen also takes priority over the urologic system.

An intravenous infusion (double dose) urogram is obtained if one suspects renal injury. One should keep in mind that multiple-system injury is the rule in most patients involved in automobile accidents.

The physician in the emergency room is the first to see the patient. An attempt may be made to carefully insert a 16 French indwelling catheter into the bladder. If urethral disruption is complete, then the catheter will meet an obstruction. A retrograde urethrogram can assist in making the diagnosis.

Controversy exists regarding the best surgical treatment for reapproximating the severed urethral ends. Many clinicians feel that a suprapubic cystostomy is the treatment of choice at the outset. Drainage of urine from the perivesical lateral sites may be necessary. The belief is that extensive



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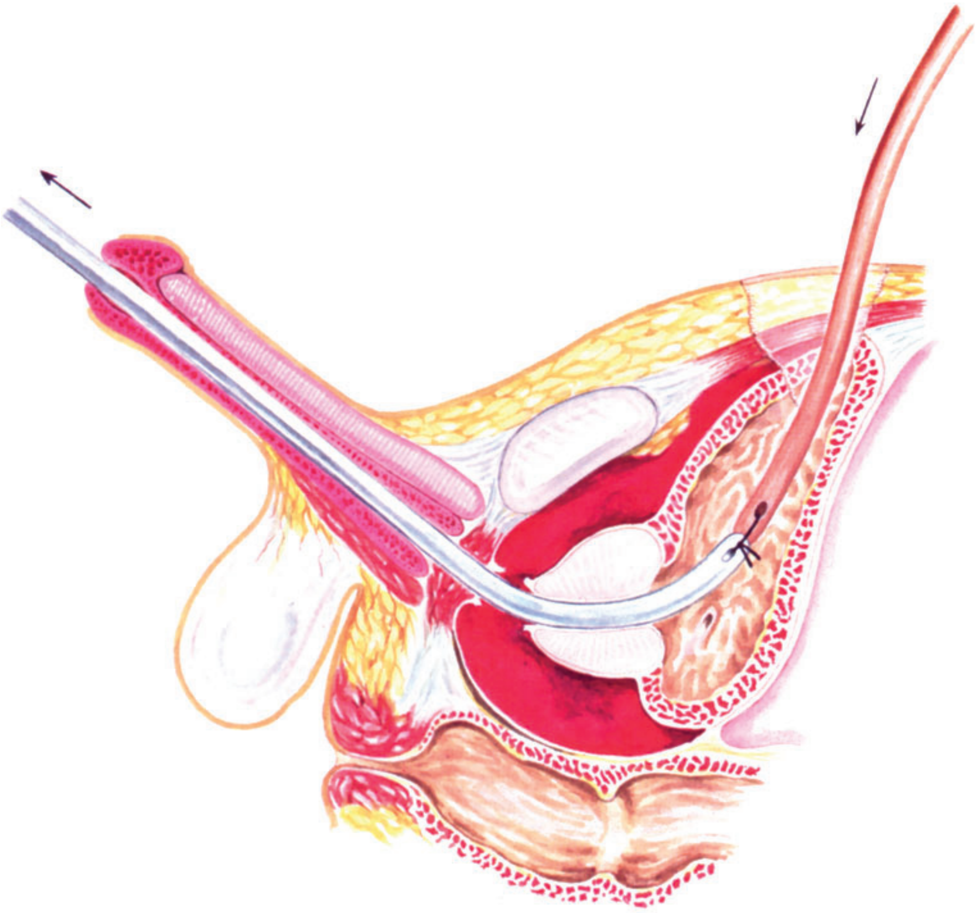

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dissection must be avoided. This school believes that potency will be preserved, and a second-stage procedure 4–6 months later will allow easy reconstruction of the injured fibrosed urethra. We adhere to this concept.

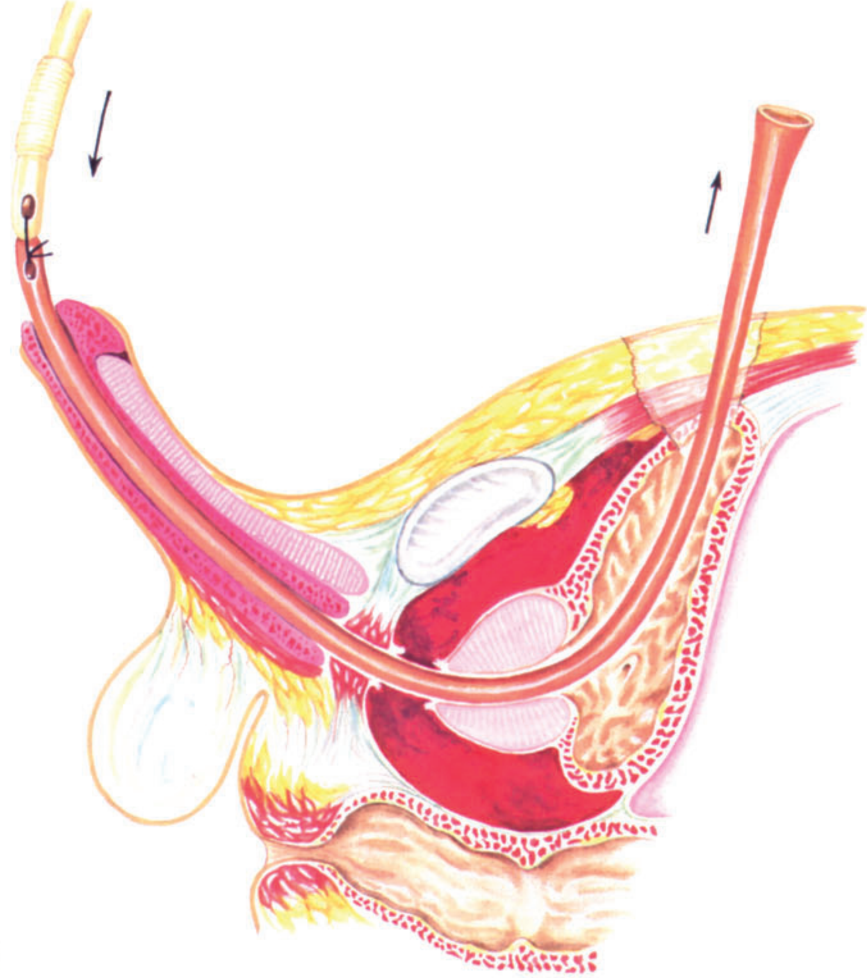
The other, larger group of clinicians believes that early reapproximation of the urethra is indicated. This surgical technique is illustrated. The patient is in a supine position. His thighs are separated and elevated over sandbags so that the perineal area is accessible.

67-1. *The bladder is entered by cystotomy.* Double interlocking sounds are carefully placed. The area of prostatic disruption is seen from this midsagittal view. The special metal sound entering the pendulous urethra also has a perforation on its tip.

67-2. The metal sound from distal urethra, which has met the proximal sound, is guided into the bladder lumen. *A straight soft rubber 18 French catheter is tied to the metal tip,* and the rubber catheter is withdrawn.

67-3. *The rubber catheter is attached outside the urethral meatus to an indwelling silicone rubber catheter* (22 or 20 French, depending on the size of the patient).

67-4. *The indwelling catheter is inserted and secured* (30 ml in the balloon). A suprapubic tube (malecot tip, 24 French) is inserted. The bladder is closed in two layers. Penrose drains are inserted on each side of the bladder neck area, and are brought through separate stab incisions.



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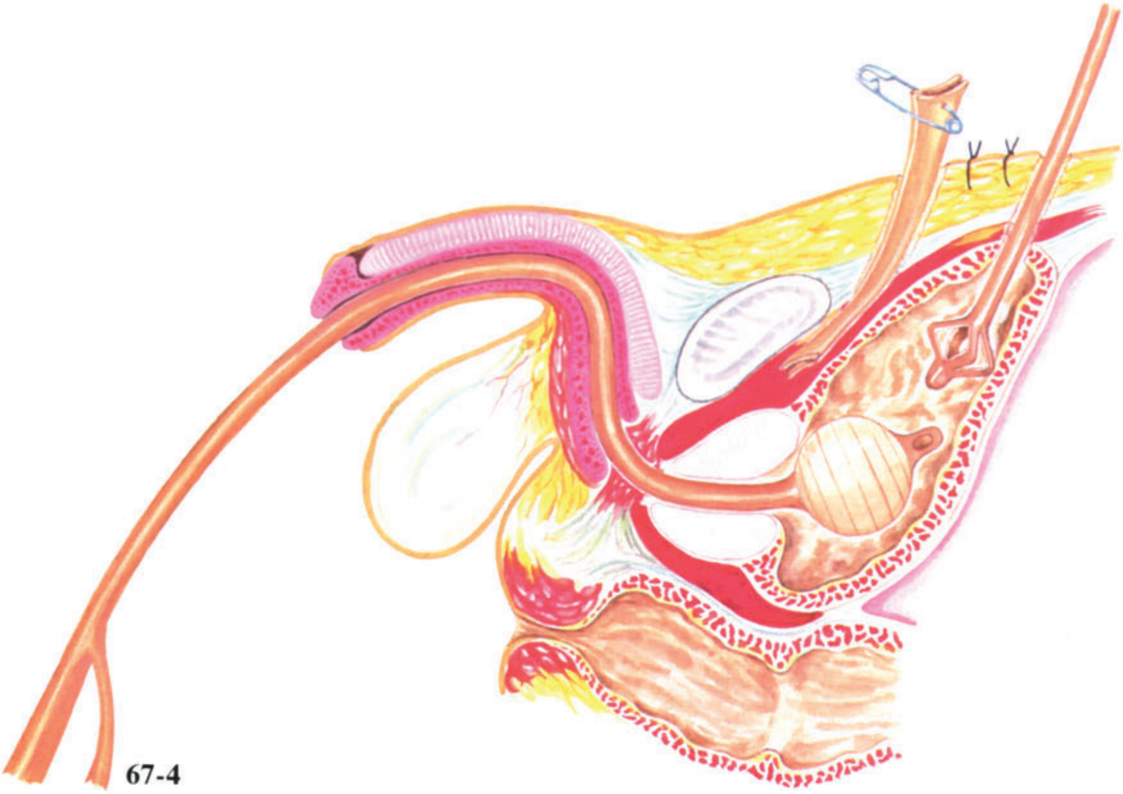


67-4

Traction-like (Vest type) perineal sutures (0 nylon) may be used; they extend from the prostatic capsule anterolaterally through the perineum. Each suture is secured over a button for 2–3 weeks. The alternative is to place a 2-pound (1-kg) weight on a pulley. The catheter emerging from the penile urethra is attached to the raised weight on an overhead pulley at a 45-degree angle from the horizontal. Care must be taken to ensure that the line of traction is secure at all times. Such traction is usually applied for a minimum of 3 weeks.

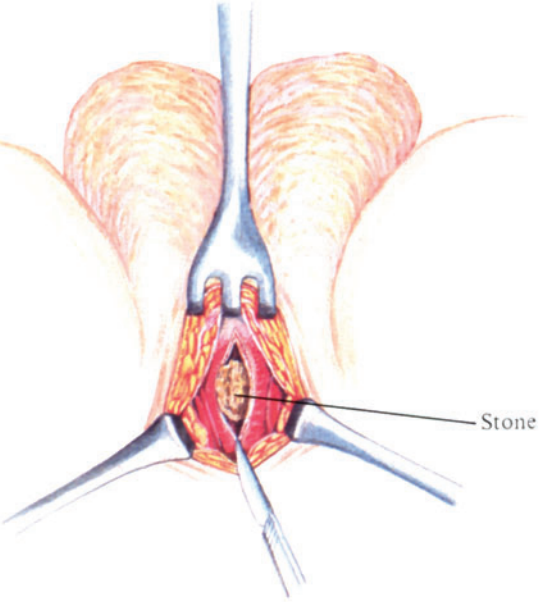
Prevention of urinary tract infection is important. Urine is cultured at least once each week from the suprapubic tube. We use the combination of trimethoprim and sulfamethoxazole for prevention of infection. The Penrose drain is usually shortened and removed by 5–7 days.

68. Perineal Urethrotomy: Removal of a Large (1.5-cm) Calculus

68-1. The calculus can be palpated. *The skin, musculature, and underlying perineal urethra is incised.* Stay sutures are placed to identify and expose urethral lumen if the margins are not distinct.

68-2. *An indwelling catheter,* 18 or 20 French (5-ml bag) *is inserted.* The urethra is reapproximated using 3-0 chromic catgut.

68-3. *Closure of the urethra is complete.* A Penrose drain is brought out laterally through a separate skin incision. The subcutaneous tissue and skin are reapproximated (3-0 chromic catgut).



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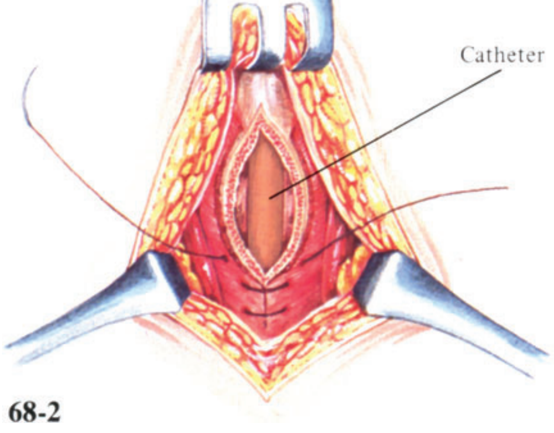

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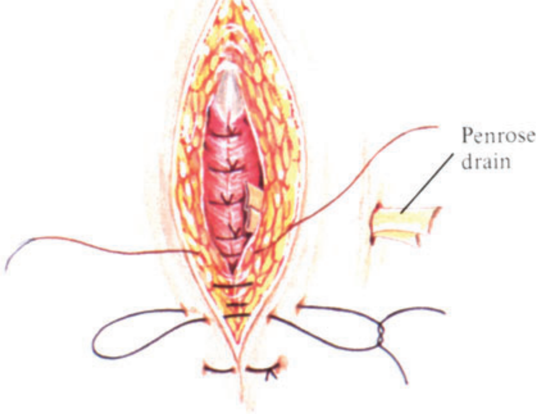

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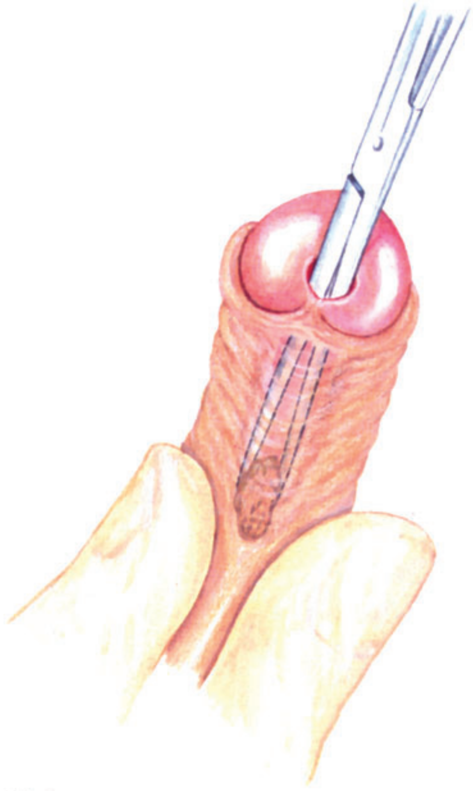
69. Transurethral Removal of Stone or Foreign Body

69-1. Under anesthesia *a straight clamp is inserted into the pendulous urethra, and the calculus is removed.* The thumb and forefinger assist in preventing migration of the foreign body.

69-2. A moderate-sized calculus (1.5–2 cm) can obstruct the prostatic urethra. *A Van Buren sound* (24 French) *is used to dislodge the calculus into the bladder.* The resectoscope (26 sheath) can also be used to dislodge the calculus into the bladder.



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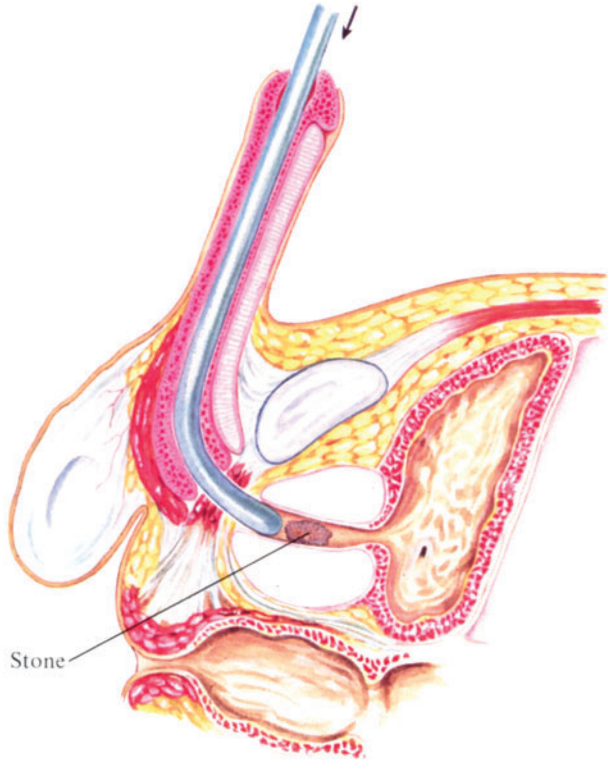

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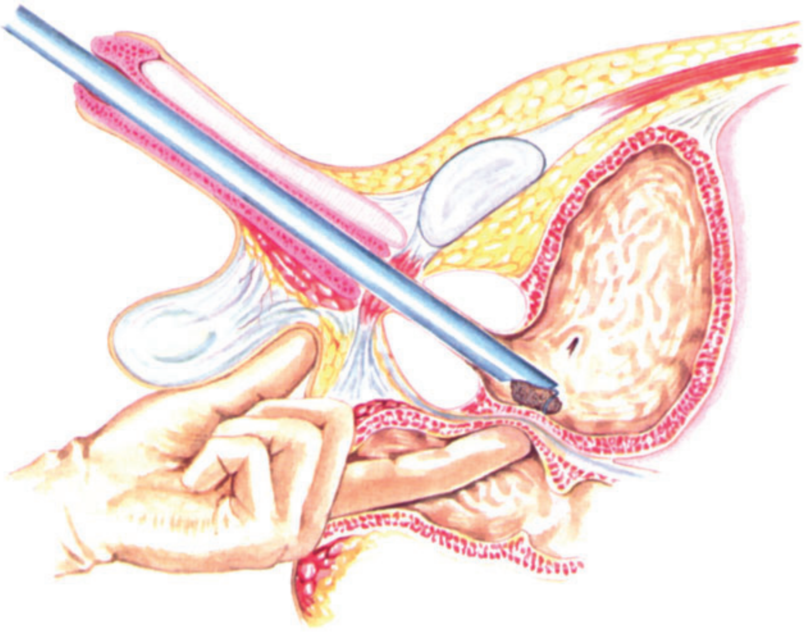


69-3

69-3. *The loop of the resectoscope can be used to trap the calculus,* and the entire instrument, including the sheath and resectoscope, can be removed through the urethra. The gloved index finger on the left is used to trap the calculus. If the calculus is too large, then the lithotrite should be inserted, and the calculus pushed into bladder should be crushed into smaller fragments. Care must be taken to ensure that all fragments are removed by means of copious irrigations.

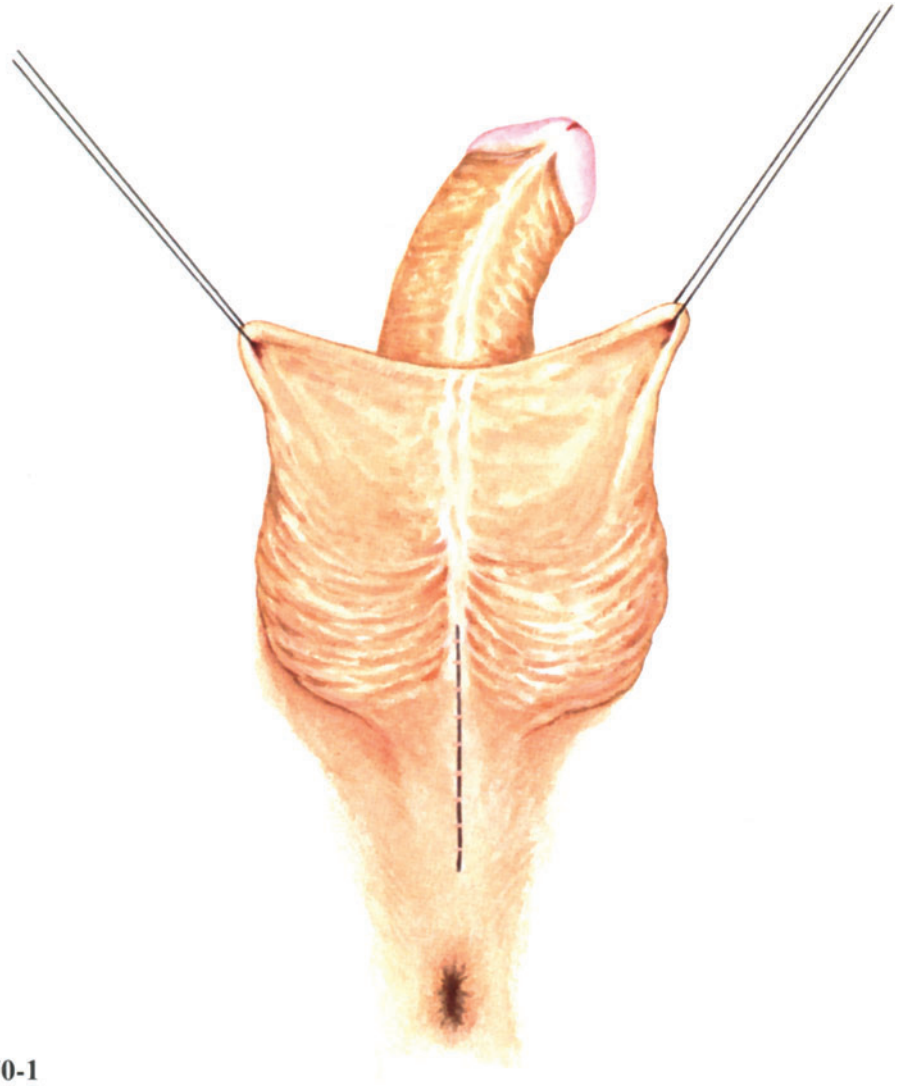
Urethroplasty

70. First-Stage Urethroplasty—Turner-Warwick Procedure

A previous retrograde urethrogram has demarcated the severity and the extent of stricture formation. In our experience, many patients have been dilated for many years, usually at intervals of a few months. They now request reconstructive urethral surgery.

Spinal or general anesthesia can be used. The patient is placed in the lithotomy position. Stirrups afford better exposure than the thigh-leg braces used in transurethral surgery.

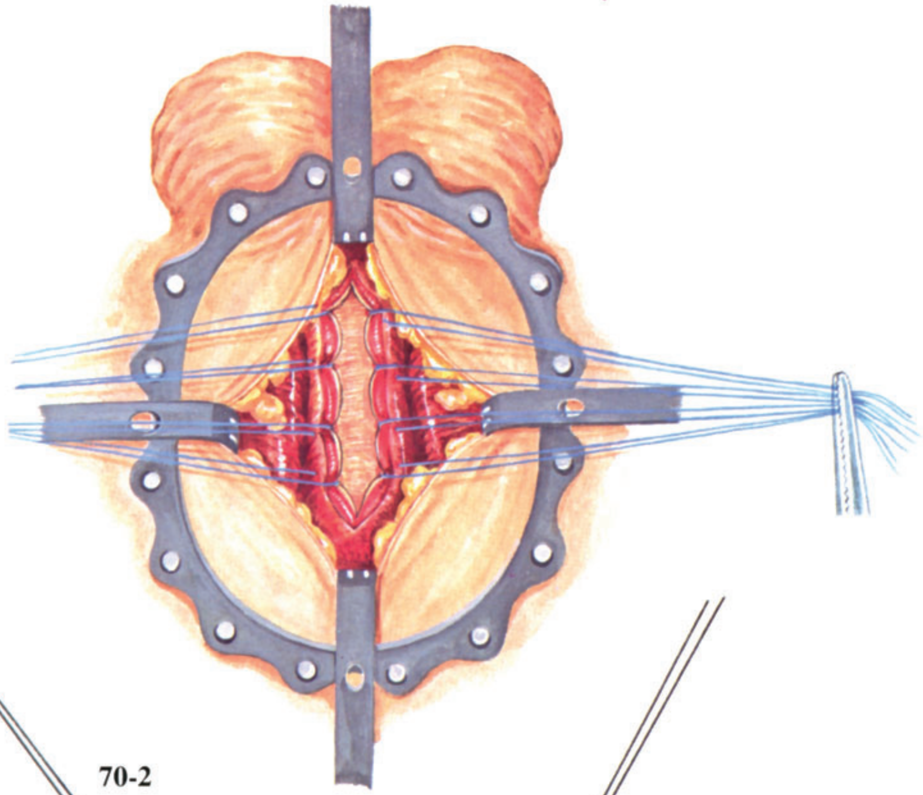
70-1. We inject a dilute solution of methylene blue dye (15 ml) through the urethral meatus to stain the strictured areas. *An incision is made (dotted line)* for a bulbous urethral stricture.



70-1

70-2. The bulbocavernous muscle is incised longitudinally. *The urethra is similarly incised, and the cut edges are retracted.* A special self-retaining retractor assists in the procedure.

70-3. *Scrotal skin is used to form the broad-based floor of the opened urethra.* The scrotal skin is tested to be sure it will reach the open urethra without tension. Stay sutures assist in the proper orientation.



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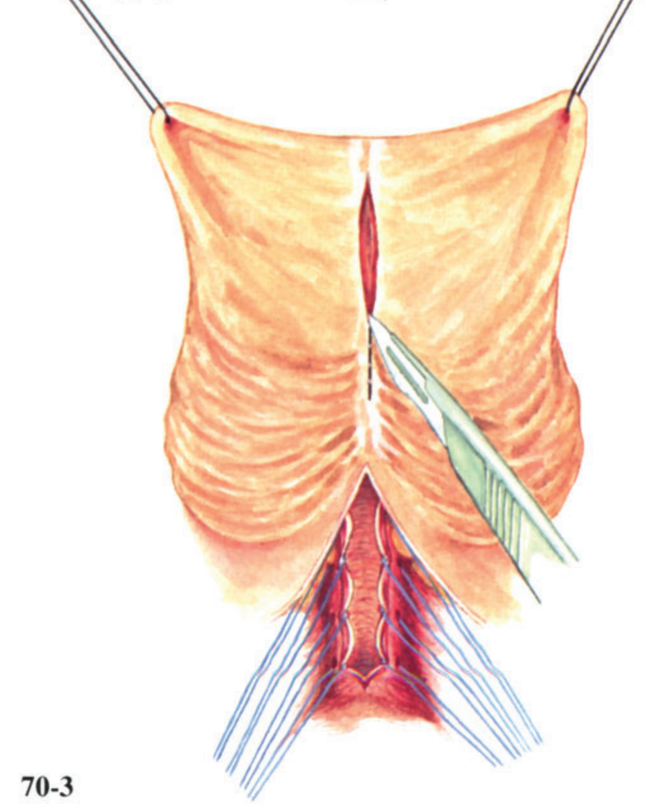
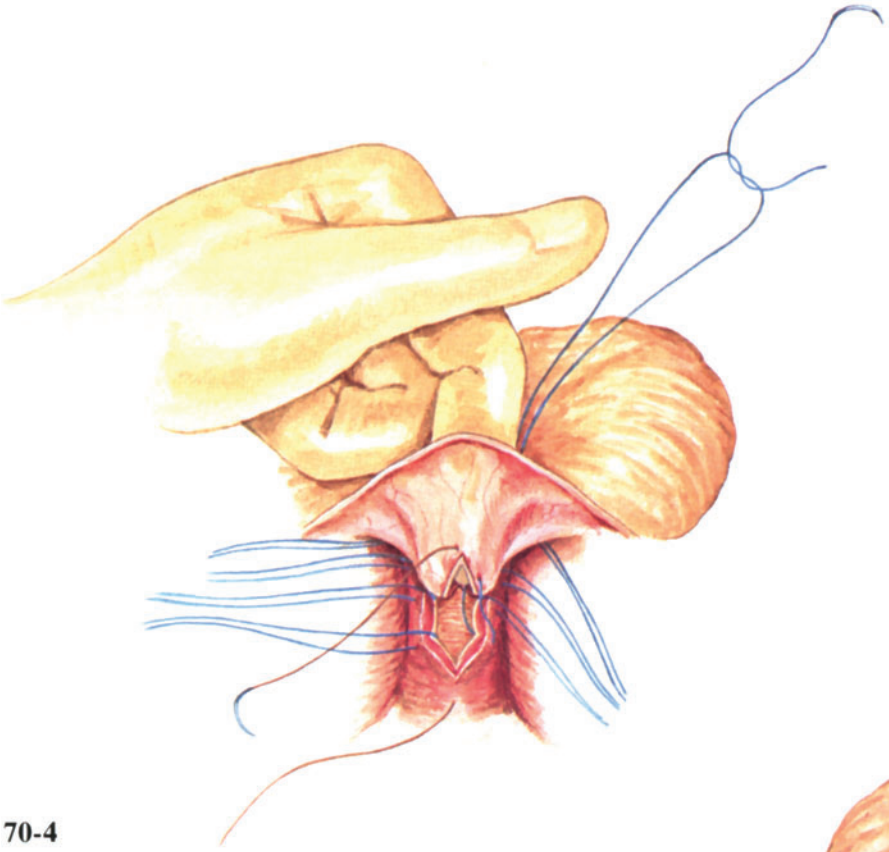


70-3

70-4. *The scrotal skin is shaped into a funnel,* and the nylon (3-0) stay sutures are brought out through the new opening in the midscrotum (*at right*). Care is taken to place the most difficult sutures at the innermost and inferior margins. An untied suture has been placed in this difficult area. Several more sutures should be placed on each side of the apex to provide a good healing margin.

70-5. *A special nasal speculum adapted for urethroplasties* is helpful in placing the deep sutures near the membranous urethra. We agree with Turner-Warwick[7] that the membranous urethra can be incised at 6 o'clock and the scrotal inlay can be taken to prostatic urethra when necessary. Special Reverdin's needles adapted by Turner-Warwick are useful for the purpose of securing the deep sutures.



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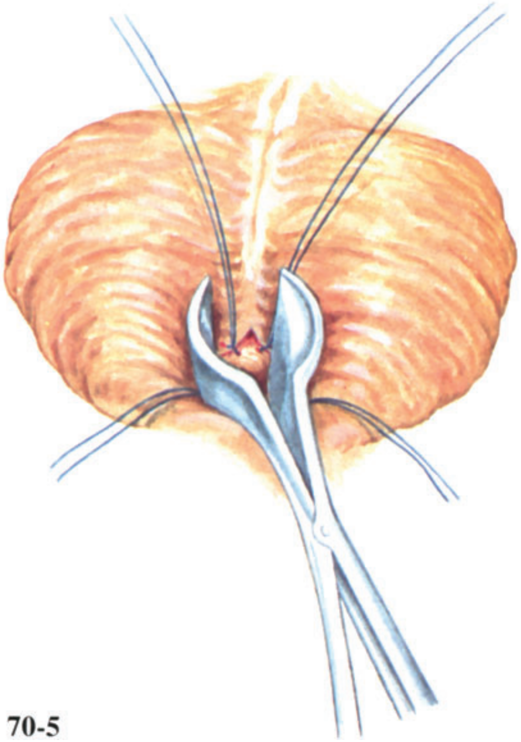

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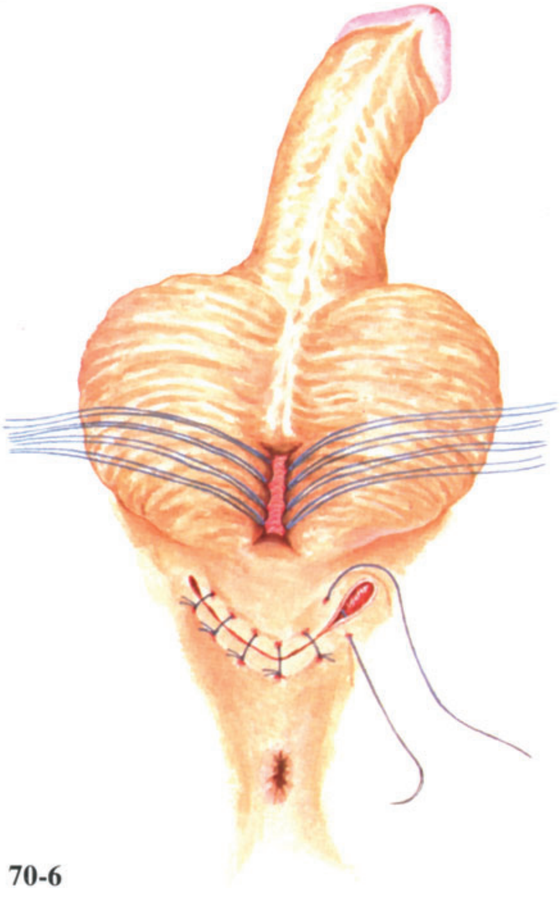
70-6. *In the completed first-stage urethroplasty,* with long tails on the nylon 3-0 sutures, the vertical perineal incision is closed transversely. A Penrose drain can be placed at each angle if deemed necessary. Both ends of the new urethrostomies should accommodate 30–32 French urethral sounds.

An indwelling urethral catheter is brought out through the new opening and left in place for 4–5 days. Before the patient is discharged from the hospital he is carefully instructed in the art of inserting urethral suppositories through each of the urethrostomies. In our opinion, fibrinous adhesions can form at the distal urethrostomy if the patient is inattentive. He is instructed to insert a urethral suppository in each direction on a daily basis.

The patient is followed regularly in the office. We will dilate both urethrostomy sites at 7 to 10-day intervals during the first month (24–28 French).

At one month in the postoperative period the patient is hospitalized (one-day short-term admission) and anesthetized. The position for cystoscopy is used. Residual hairs in the scrotal inlay are removed by epilation. Gentle traction is maintained on each hair while the fine needle is inserted beside it to the follicle. We use the 12-volt DC apparatus currently used by plastic surgeons for removal of eyelashes. Only a few seconds are necessary before each hair is released from its follicle.

The nylon sutures are removed with a small knife blade at the deep scrotal-urethral interface. Cystoscopy is performed to be sure benign prostatic hypertrophy or bladder neck obstruction is not also present. If the prostate is significantly enlarged, then transurethral resection of the pros-



70-6

tate is performed during a subsequent admission. Both urethrostomies are carefully calibrated and dilated (24–28 French distally, 28–34 French, proximally).

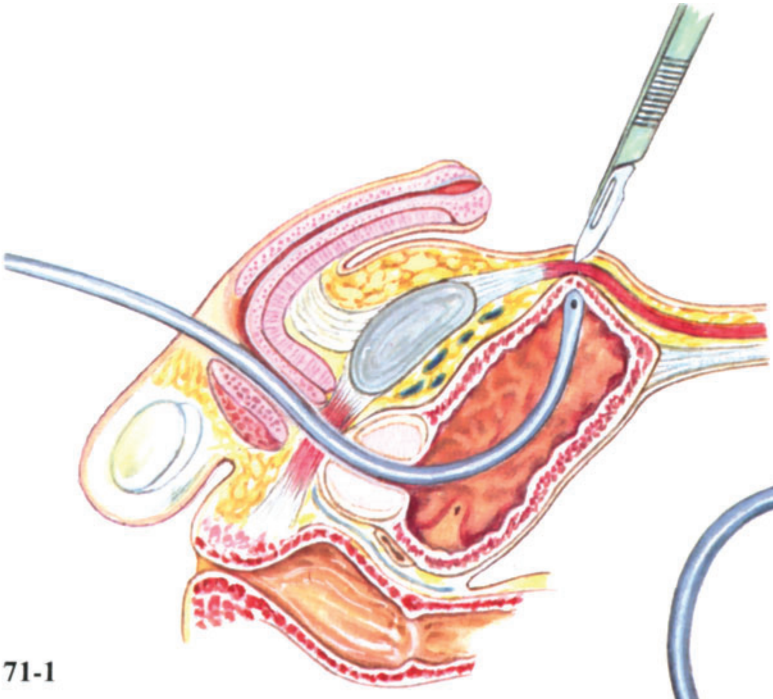
If transurethral resection of the prostate is indicated, then this procedure is scheduled in the interim, and the second stage urethroplasty is not performed until 4–5 months have elapsed.

71. Second-Stage Urethroplasty—Turner-Warwick Procedure

The patient is placed in the lithotomy position. We prefer the stirrups for elevation of the lower extremities. General or spinal anesthesia may be used.

71-1. *A special sound perforated on its tip* (26 French) *is inserted.* A small suprapubic skin incision is made and carried in the midline through the fascia of the rectus abdominis muscle. Tenting upward on the sound allows easy identification of the bladder wall.

71-2. The perforated tip of the sound allows *an indwelling urethral catheter* (20 French, 5-ml inflatable bag) *to be secured.* Heavy silk (No. 1) is used to approximate both tips. The catheter is drawn into the bladder and out the proximal urethra.



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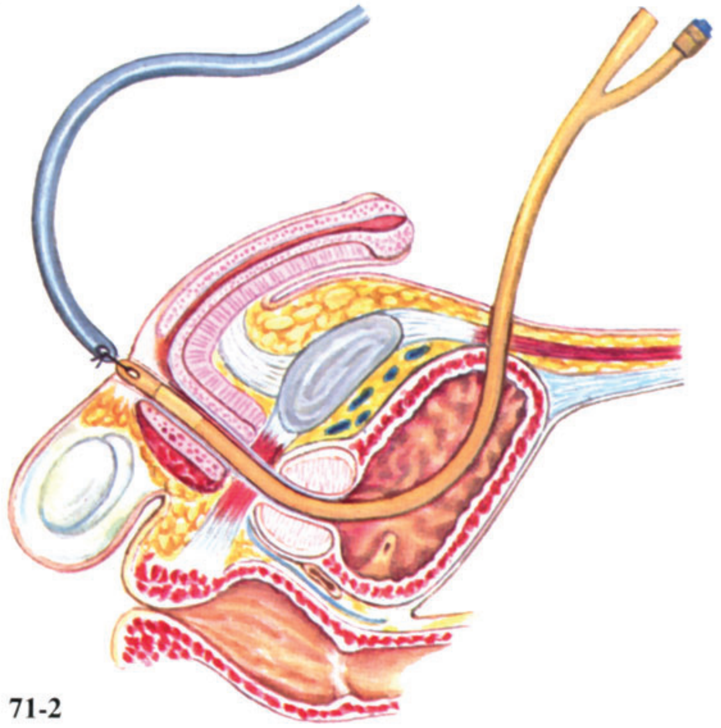


71-2

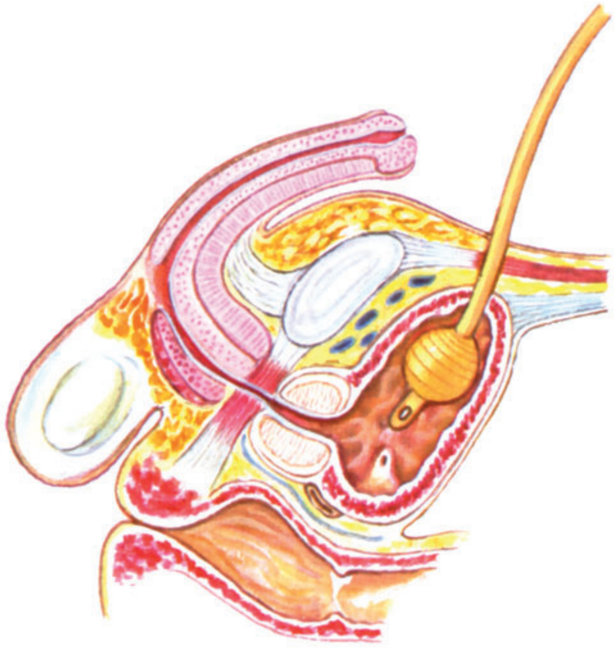
71-3. The tie is released and the catheter is carefully retracted into bladder lumen. *The bag is inflated* and the catheter is irrigated to be sure that its tip is in the bladder lumen. The suprapubic cystostomy should take only a few minutes.

71-4. We believe that *the border of the new urethra should be marked (broken line).* Stay sutures often assist in proper orientation.

71-5. The *new tube of skin has been freed.* The outer skin margin must be undermined so that a second layer of closure can be reapproximated without tension.

71-6. *A continuous stitch is used to tubularize the new urethra* (3-0 chromic catgut). The suture line does not include the skin edge but is subcuticular in its location. After completion of the new urethra, subcutaneous tissue is brought over the urethra to provide a partial middle-layer closure.

71-7. *The skin is reapproximated with interrupted 4-0 nylon sutures* as a second covering layer. The suprapubic tube is secured to the skin.



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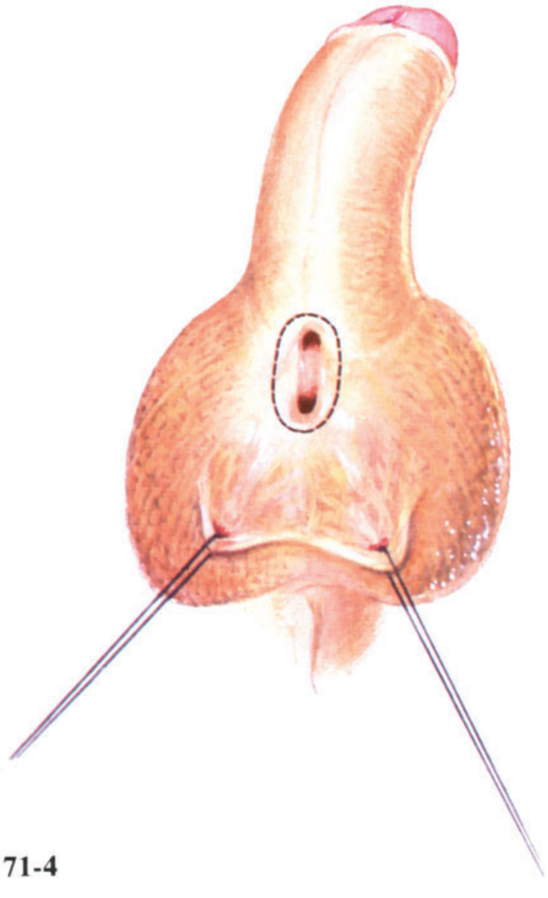

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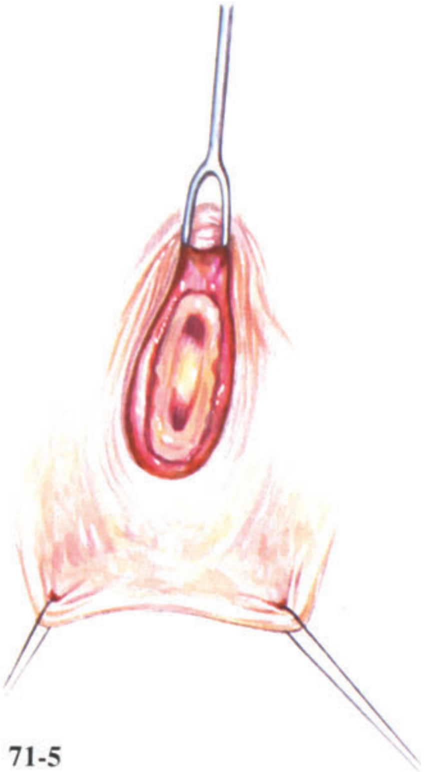

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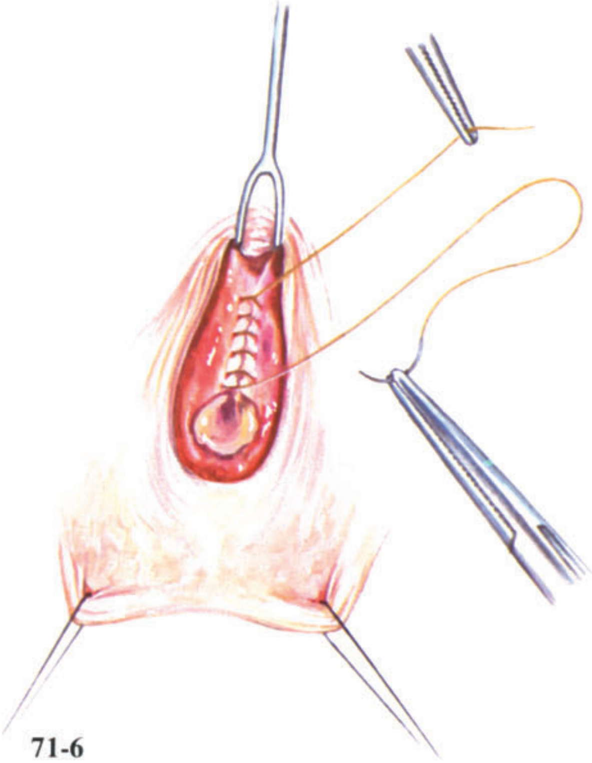

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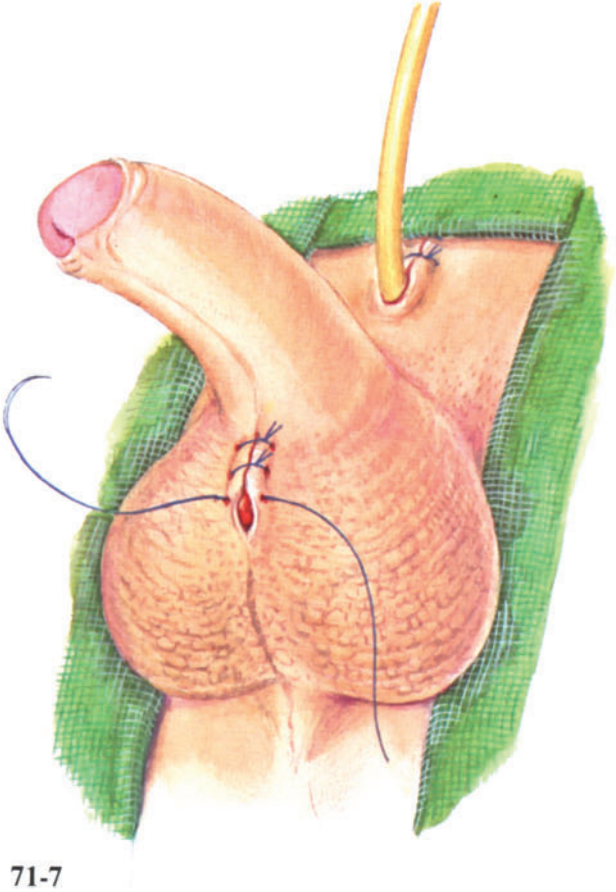


71-7

Posterior Urethroplasty

72. First-Stage Urethroplasty

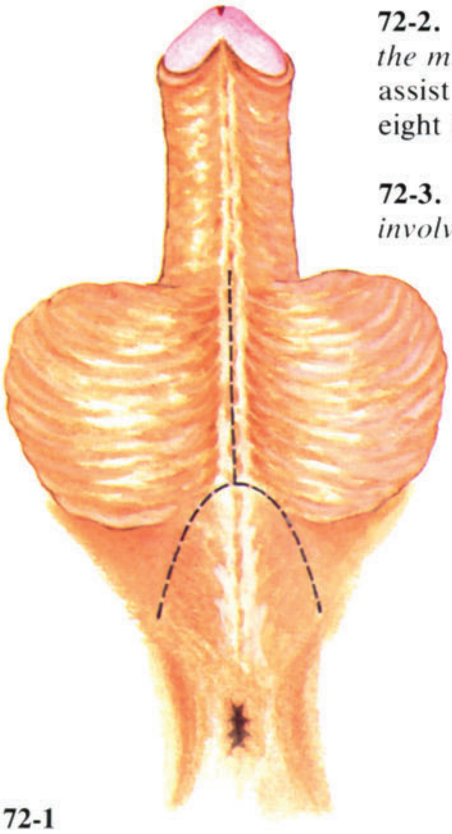
Subtle differences exist between the Leadbetter technique[4] described in 1960 and the Gil-Vernet technique[3] reported in 1966. The technique presented here resembles the procedure described by Gil-Vernet.

Spinal or general anesthesia may be used. The patient is in a slightly exaggerated lithotomy position. A urethrogram has been obtained, and the strictured area is in the deep bulbous urethra and extends distally.

72-1. When a long stricture is present, *an inverted U incision is made (dotted lines).* The vertical arm of the incision across the scrotum is employed in this procedure.

72-2. The perineal flap is freed. *The bulbocavernosus muscle is divided in the midline, and the urethra is incised beyond the strictures.* Stay sutures assist in providing exposure. Hemostasis must be maintained. Figure-of-eight sutures in the muscle may be needed to secure hemostasis.

72-3. The schematic demonstrates *the long stricture (undulations) in the involved urethra.* The perineal flap is seen.



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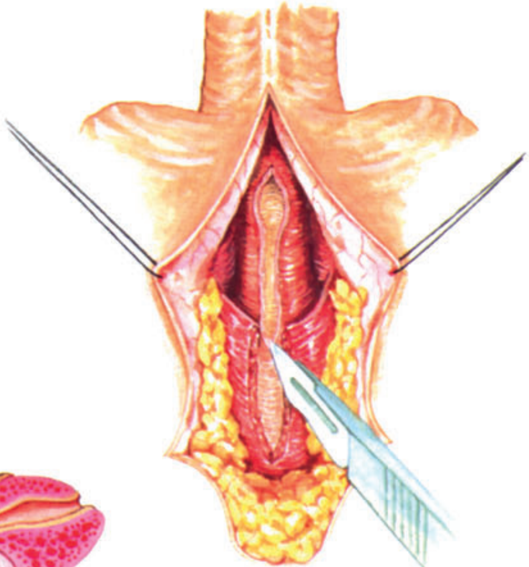

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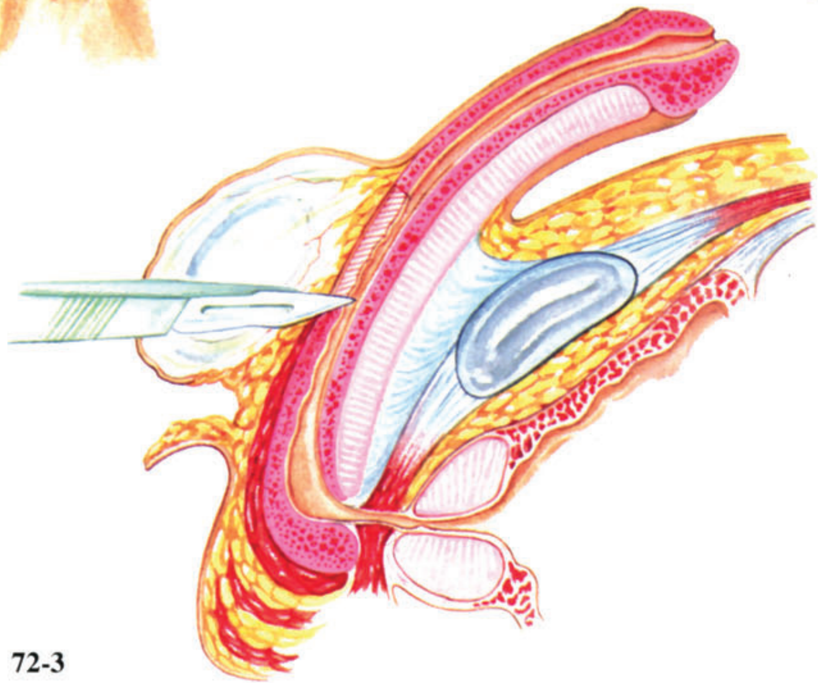


72-3

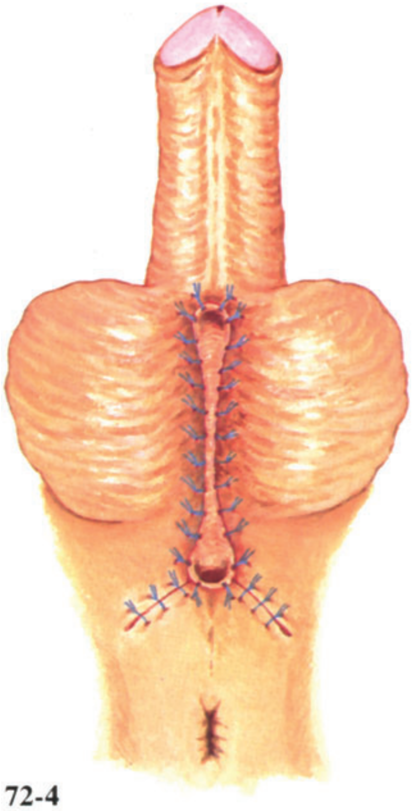
72-4. *The posterior flap is laid into the floor of proximal urethra.* The edges at the interface are sutured with 3-0 nylon. The entire urethra is sutured to skin margins as demonstrated. A catheter into the proximal urethra is inserted and maintained for 4–5 days. Stitches are removed in approximately 2 weeks.

73. Second-Stage Urethroplasty

Before the second-stage urethroplasty is performed the patient is cystoscoped to rule out significant prostatic hypertrophy. Transurethral resection of the prostate, if deemed necessary is completed before the second stage urethroplasty. A suprapubic catheter may be inserted (see 71-1 through 71-3). The patient is positioned as usual.

73-1. *The new urethral tube to be formed is carefully marked (dotted line).*

73-2. *The tube of new skin is sutured, in part, over a stenting urethral catheter* (22 French). It is important to undermine both skin edges so closure can be accomplished without tension (3-0 chromic catgut).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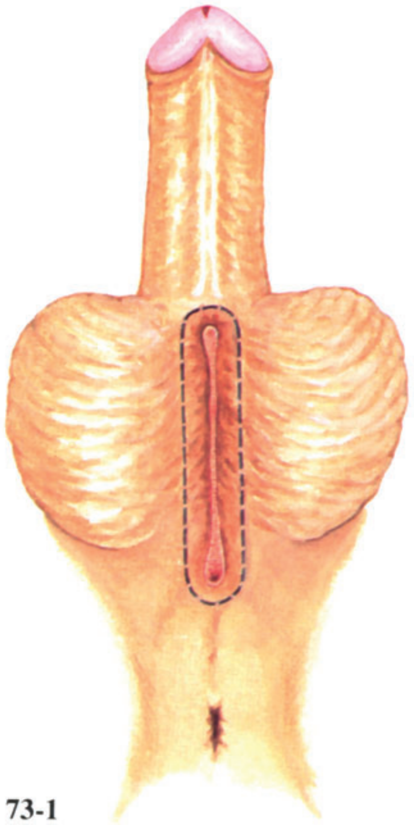
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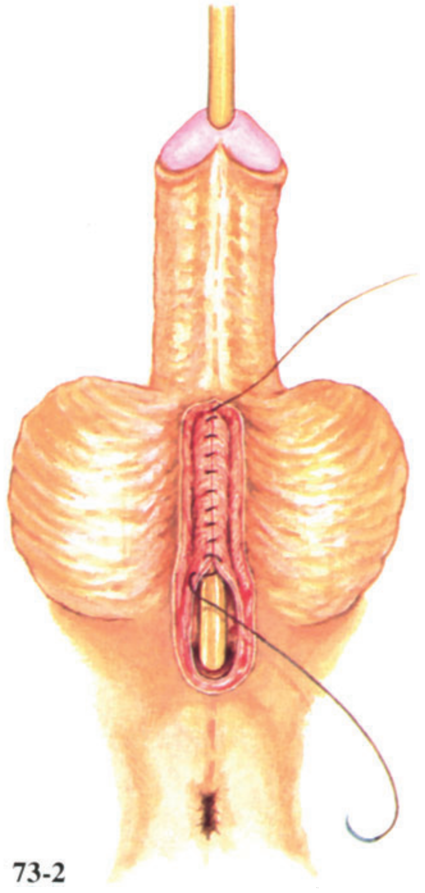

73-2

73-3. *A second layer of subcutaneous tissue is fashioned to cover the new urethra.*

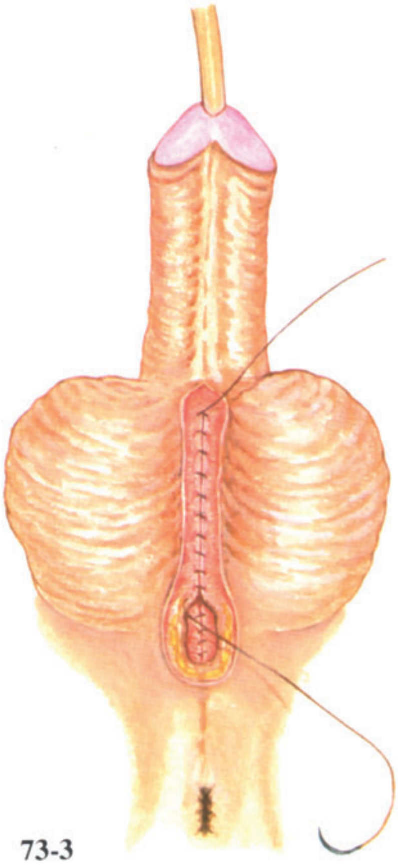
73-4. *The skin is reapproximated with interrupted 3-0 nylon sutures.* We prefer removal of the urethral catheter since a suprapubic catheter is inserted at the beginning of this procedure.

74. Modified First-Stage Posterior Urethroplasty

Pierce[6] has described his experience with difficult posterior urethral strictures. His procedure is similar to the techniques described by Leadbetter and Gil-Vernet.

74-1. We have modified the posterior perineal flap technique of Pierce, so that mobilization is provided at the proximal and distal urethrostomy sites, where stenosis usually may occur. *The lines of incision* are marked.

74-2. *The 3-0 nylon sutures are placed in interrupted fashion.* Our modification at the proximal stoma allows greater relaxation than that obtained with Pierce's method.



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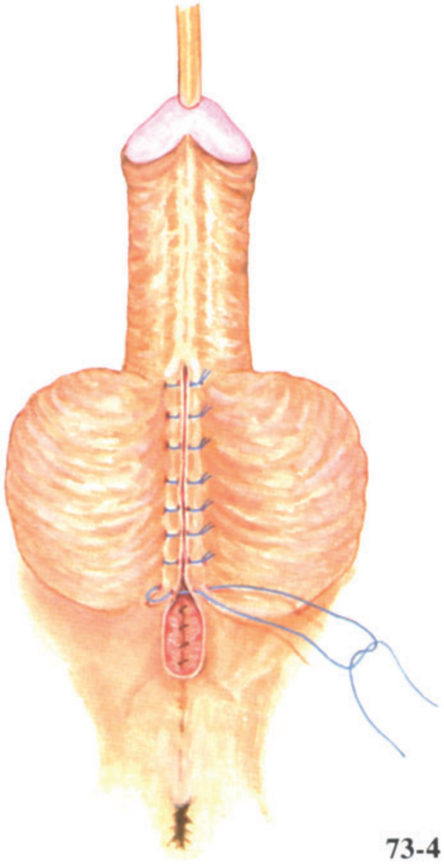

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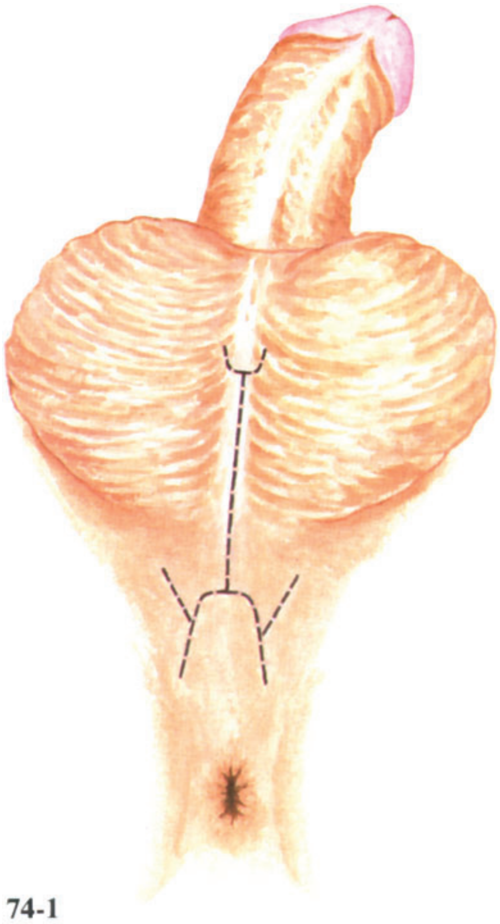

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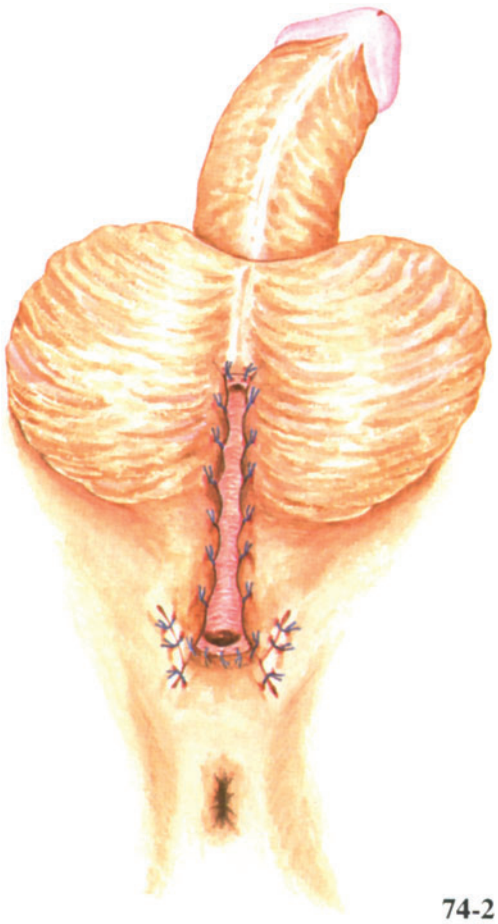


74-2

Multiple-Stage Repair of Hypospadias with Chordee Removal

Hypospadias is a congenital deformity. Incomplete development of the urethra is the basic defect. This anomaly occurs in about 2 of 500 births. The etiology is unknown.

The prepuce is usually deficient ventrally. A redundant dorsal hood is present. A broad band of fibrous tissue extends from the abnormal meatus to the glans and shortens the ventral aspect, causing the familiar curvature —chordee.

The usual classification of hypospadias is based on the anatomic location of the urethral meatus:

1. Ventrum of glans penis or juxtaglandular
2. Distal penile or coronal
3. Proximal penile
4. Penoscrotal junction
5. Scrotal
6. Perineal

The corrective operation for hypospadias should be performed after 2 years of age. If the penis is exceedingly small, then the operation is delayed another 6 months.

75. First-Stage Hypospadias Repair

75-1. In a midscrotal type of hypospadias *the line of incision is circular (dotted line).*

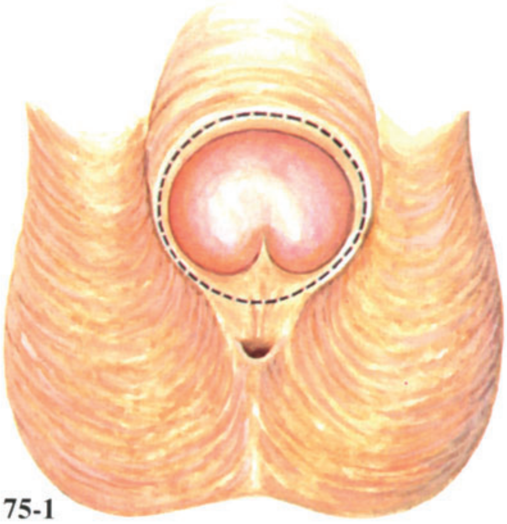
75-2. Several stay sutures are placed through the glans penis. A silk stay suture may be preferred. *The fibrous tissue comprising the chordee is excised.* Note the lateral boundaries of chordee. The proximal border is the urethral stoma.

75-3. The chordee has been removed to the urethral opening. *The skin flap and hood are elevated with skin hooks.* A window made in the dorsal skin will slip over the glans penis.

75-4. The dorsal hood with the window has been slipped over the glans penis. *Allis clamps provide orientation.* The new skin margin and the skin edge around the corona are reapproximated with 4-0 chromic catgut. The rectangular flap of skin will be used to create a distal urethra.

75-5. *The new tube of distal urethra is fashioned,* and the glans penis is also tunneled to allow placement of the distal tubular urethral flap at the tip.

75-6. *A stent* (10 French silicone or rubber tube) *is left in place.* The new floor of the ventral penis is formed by suturing the edges. A scrotal catheter is inserted into the bladder and left indwelling for 5–6 days.



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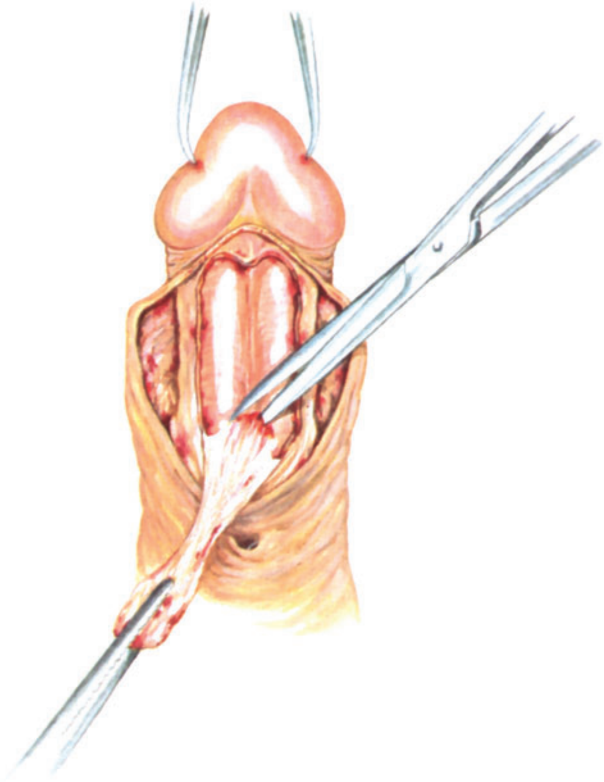

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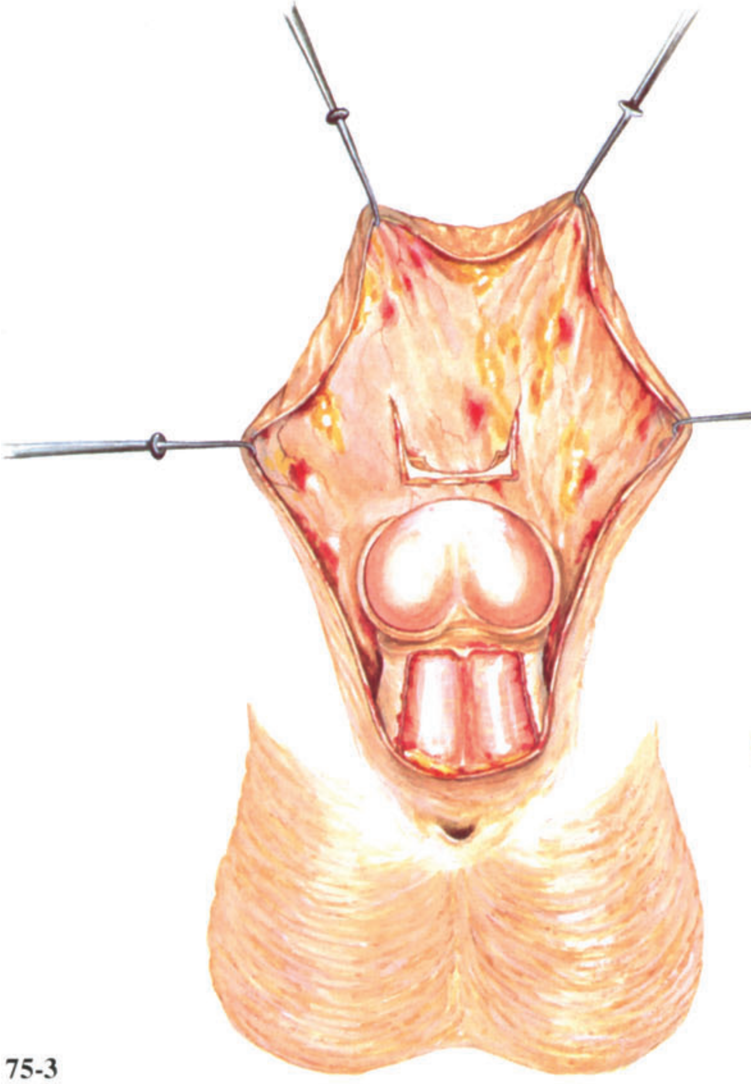

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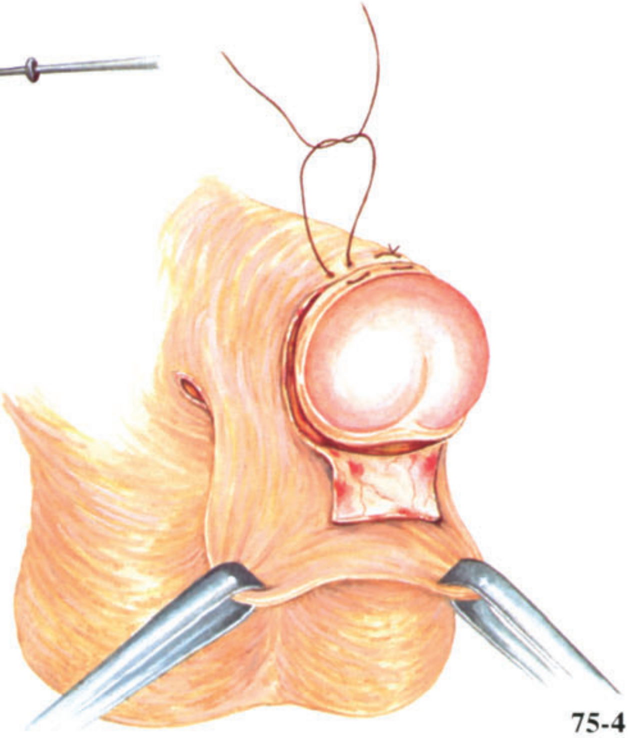

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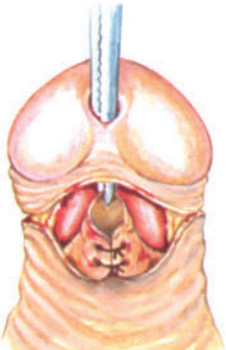

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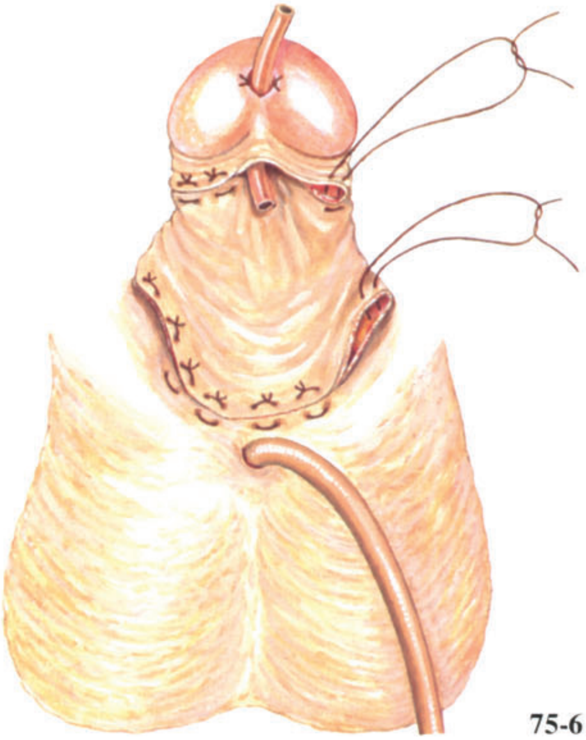


75-6

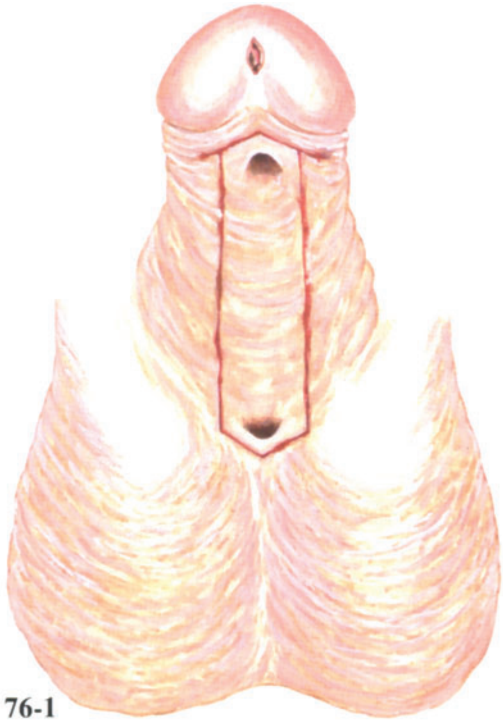
76. Second-Stage Hypospadias Repair (Abundant Skin Available)

An interval of at least 4 months is allowed before a second stage hypospadias repair is undertaken.

76-1. Adequate penile skin is available. *The skin to be used in fashioning a new urethral tube is incised.* A stay suture through the glans penis is helpful in the operation. Note the horizontal extension of the skin incision at the corona.

76-2. *A urethral catheter serves as a stent* (8 French in a child). The inner tubular skin flap is reapproximated around the stent. A running inverting suture is used to place skin edge in apposition on the interior (3-0 chromic catgut).

76-3. The second layer of skin closure is accomplished with a running subcuticular suture (3-0 chromic catgut). The transverse distal penile skin closure has been made to relieve the urethra of undue tension. The cross-sectional insert reveals the double-layer closure. The catheter within the urethra is shown in dark brown (*insert*). An indwelling catheter (10 or 12 French) is left in the bladder for at least 7 days.



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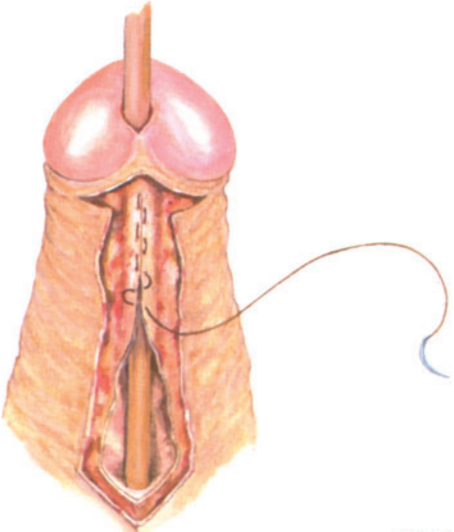

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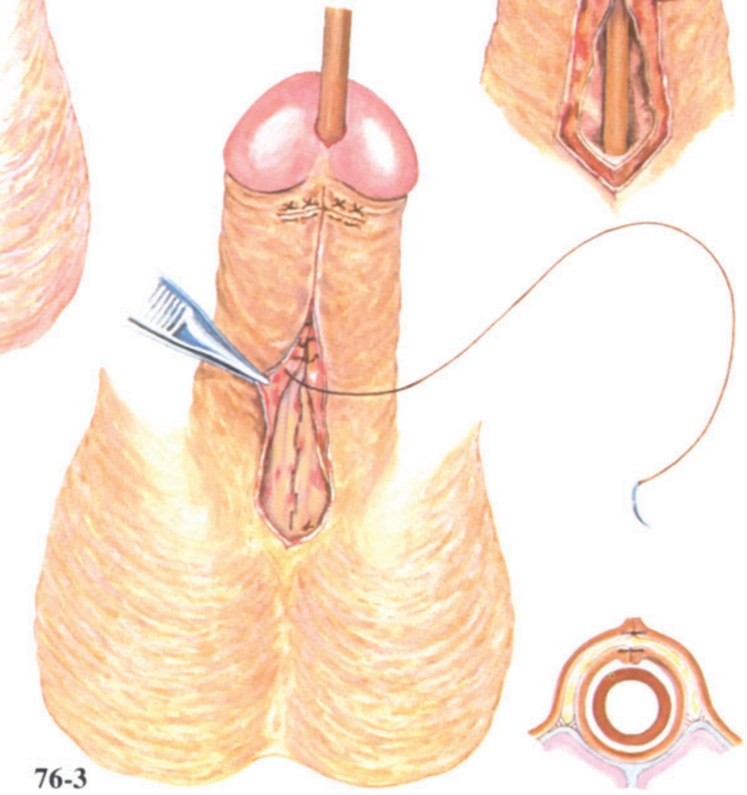

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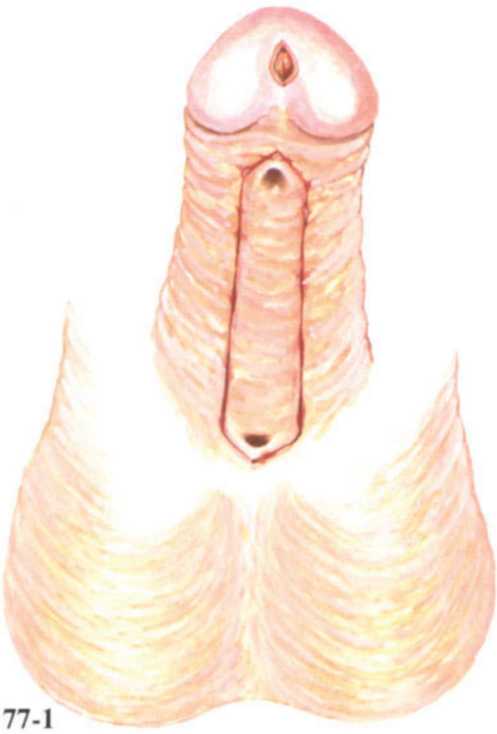

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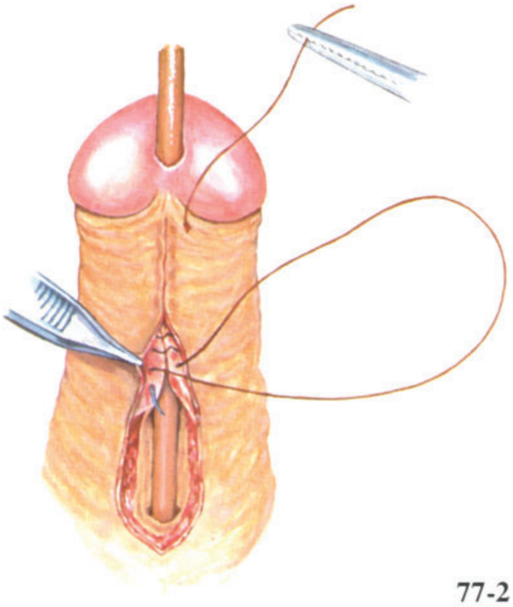

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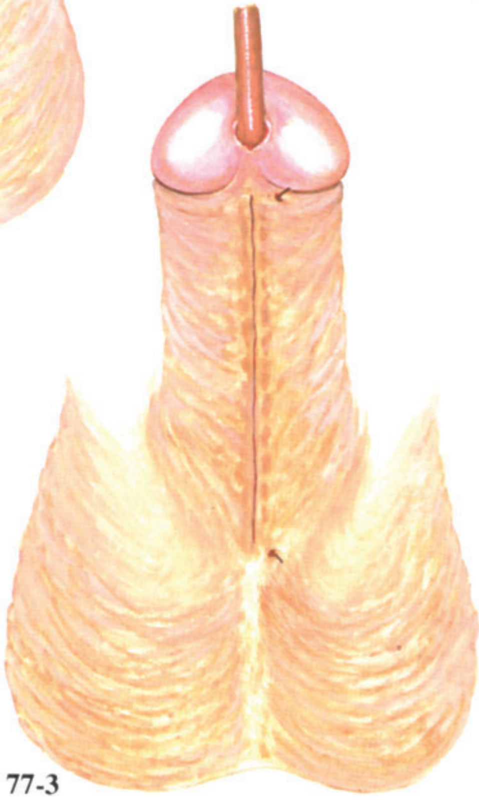

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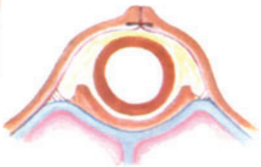


77. Second-Stage Hypospadias Repair (Marginal Skin Available, D. Browne[1] Technique)

A perineal urethrostomy or suprapubic cystostomy is completed prior to the repair (14 French catheter).

77-1. *The skin is incised for tubularization.* A one-layer closure is effected by using a single-layer closure (3-0 chromic catgut).

77-2. The stent is helpful in bringing together both skin edges. *The subcuticular closure is started at the glans. (Insert) A cross section shows the paucity of skin and the single-layer closure around the catheter.*

77-3. To complete second-stage hypospadias repair, *the final remaining suture proximally is brought through the skin and tied.* The stent is removed.

78. One-Stage Repair of Hypospadias

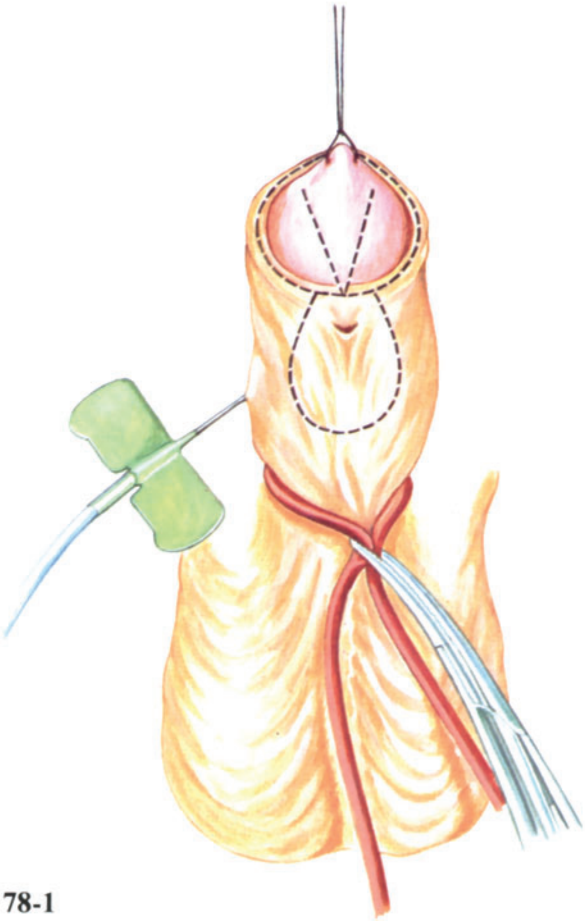
The Devine-Horton[2] modification of the Mustarde operation is used for distal penile location of the urethra.

78-1. *A stay suture is placed through the glans penis and a tourniquet is around the base of the penis.* A small needle (24-gauge) is inserted into the right cavernous body, and saline is injected to produce an erection. The extent of chordee formation can be appreciated after this maneuver. The dotted lines form the boundaries of several skin flaps. A circumferential incision is also made around the coronal skin margin.

78-2. The skin edges on the ventral surface of the penile shaft are raised and elevated with skin hooks. *The fibrotic tissue representing chordee is removed by sharp dissection down to the glistening fascial sheath.* The glans penis sits as a cap on the distal penile shaft.

78-3. *Three triangular flaps of glans penis and underlying tissue are created* by sharp dissection. (The flaps are held by skin hooks.) Care is necessary to keep the flaps thin and yet viable. Hemostasis must be meticulously controlled at all times. The lateral borders where chordee has been removed are visible.

78-4. *A flap of skin attached to the urethral meatus is fashioned* by sharp dissection so that it may be flipped up. Care is necessary to avoid making "buttonholes" in the flap. A sound or stent can be inserted to check the urethral walls when necessary. Skin hooks aid in freeing this flap. The triangular flaps formed from the glans penis are also visible.



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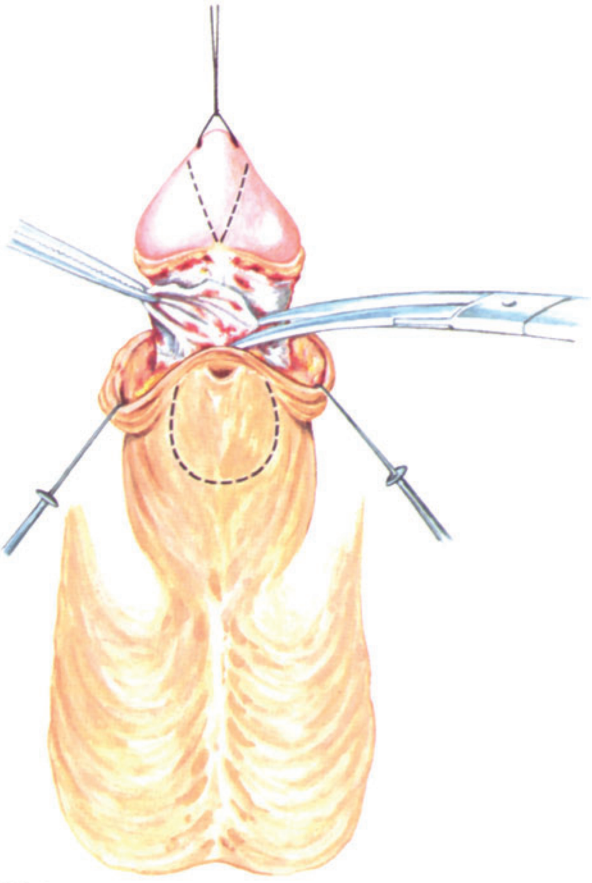

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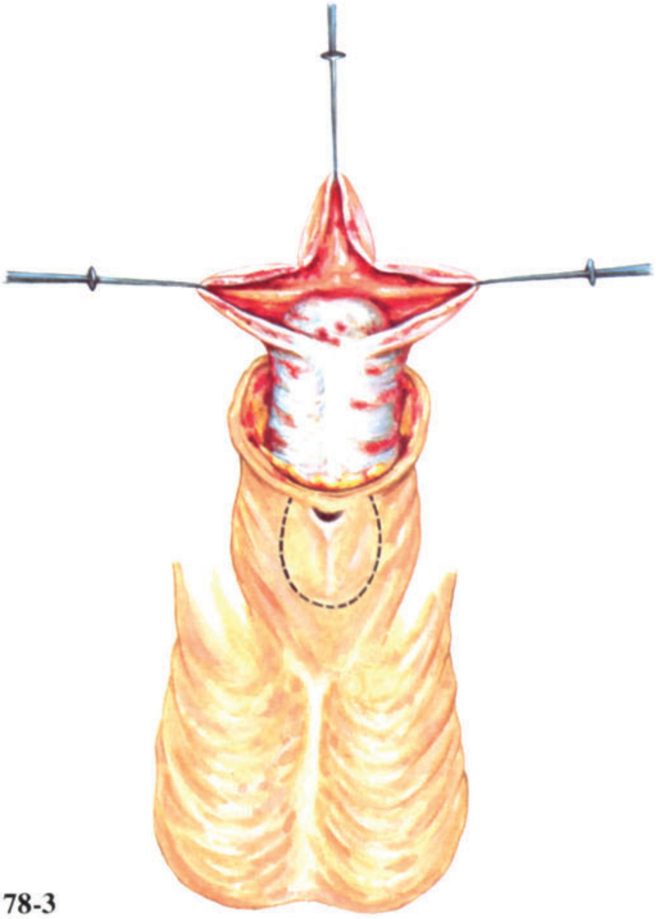

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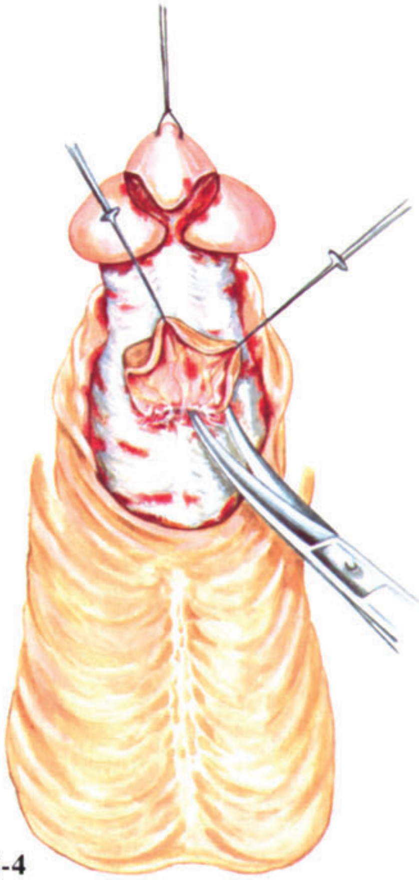

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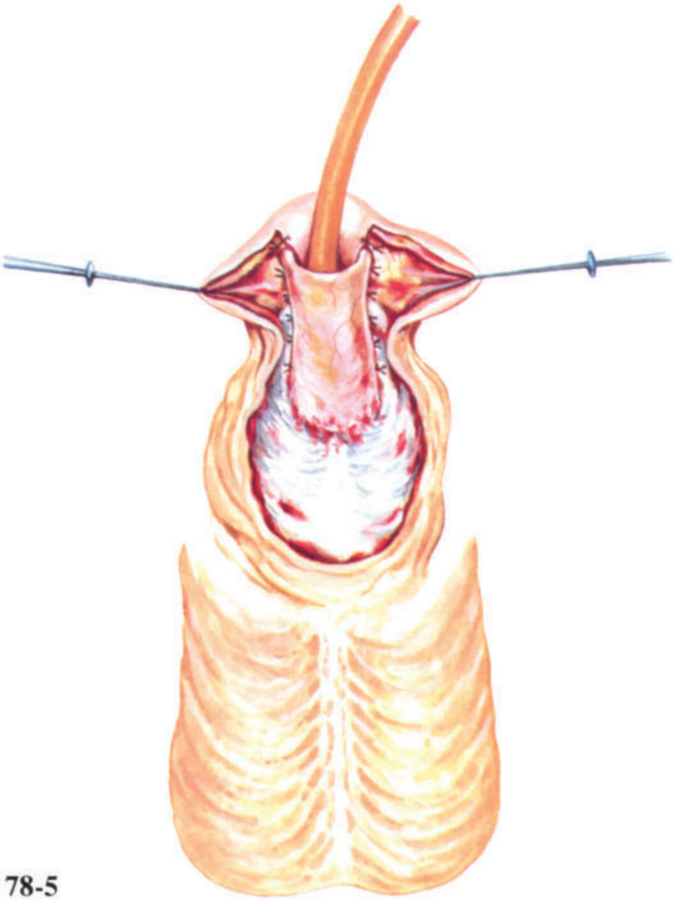

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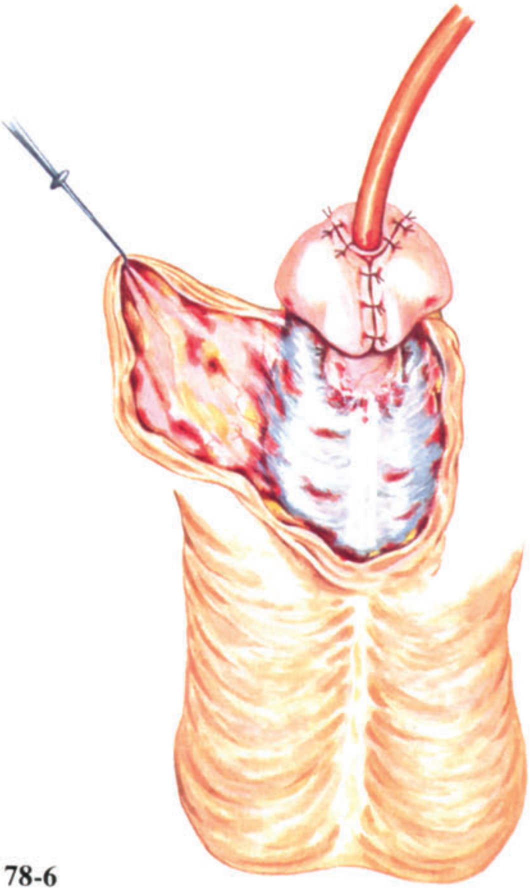

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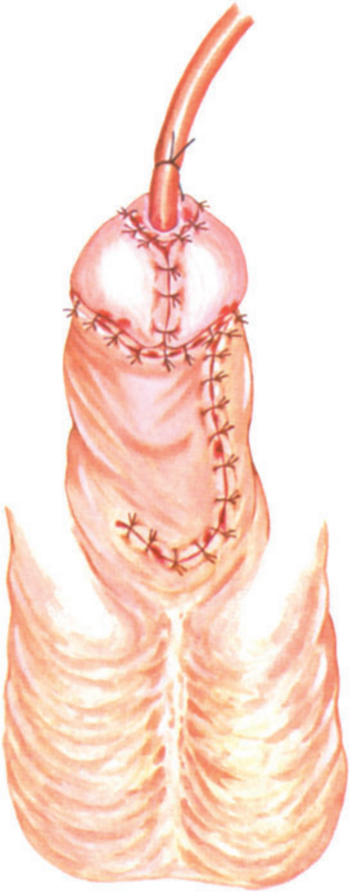


78-7

78-5. *The flap extending distally from the urethra is tubularized,* using 3-0 chromic catgut, starting proximally and extending to within a centimeter from the end. The middle triangular flap is then tucked proximally and sewn to the remaining centimeter of tubular flap to ease the tension and widen the stoma.

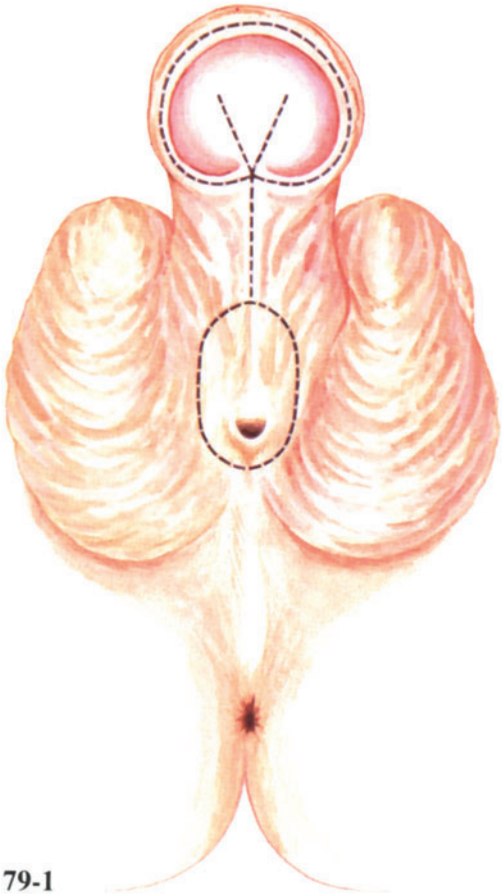
78-6. *The remaining two triangular flaps are secured around an indwelling straight Robinson catheter* (10 French) and sutured to the adjacent margins. The dorsal penile skin is then incised longitudinally for about 4–6 cm and each skin edge is brought laterally to the ventrum of the penile shaft. Hemostasis must be judiciously maintained at all times.

78-7. *The skin on the shaft of the penis is closed.* The coronal skin edge attached to glans penis is reapproximated to the skin flaps with 3-0 chromic catgut, and the stay suture in the glans penis is used to secure the straight Robinson catheter. The catheter is left in place for 5 days. A special slightly compressive dressing surrounded by elastic bandage (Elastoplast) is created around the penile shaft, pointing vertically from the horizontal suprapubic skin margin. This helps in controlling some of the ooze.

79. One-Stage Repair of Perineal Hypospadias

In this technique a full-thickness tubular graft is formed from preputial skin to bridge the gap. A suprapubic cystostomy tube is inserted at the outset to divert urine away from the area of reconstruction.

79-1. *The lines of incision into skin edges.* Although not shown, we place a silk suture through glans penis to aid in the orientation.



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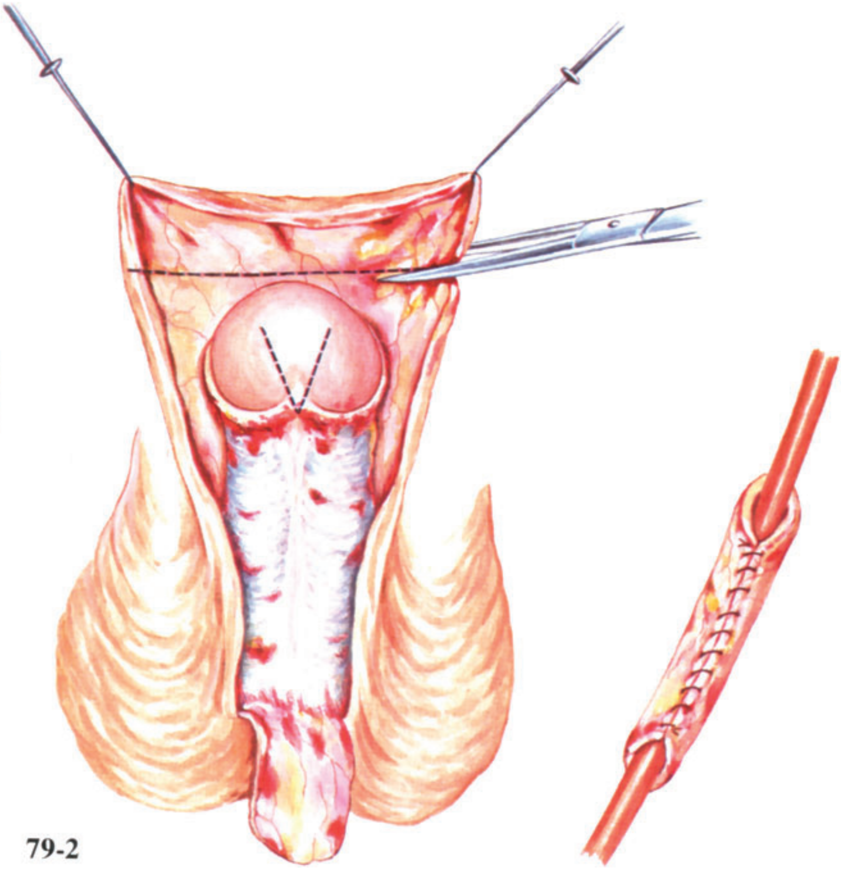

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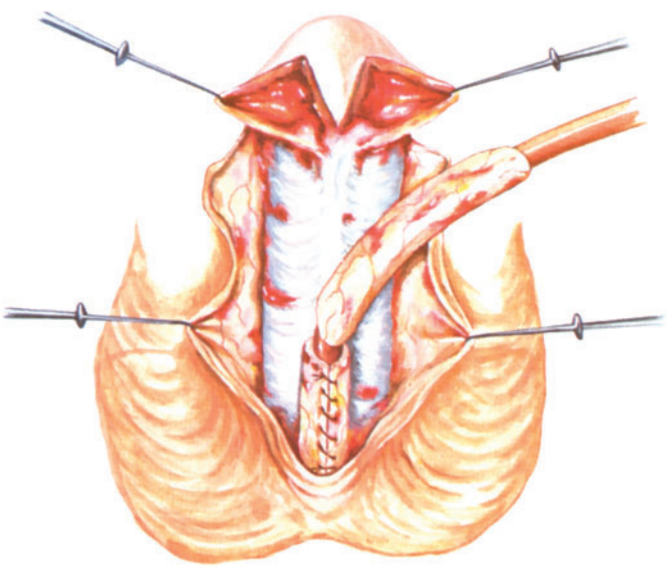

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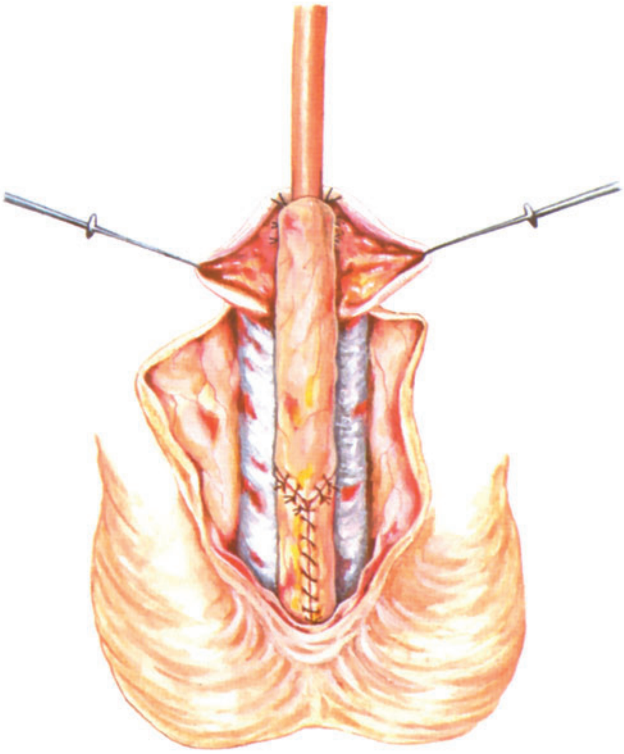

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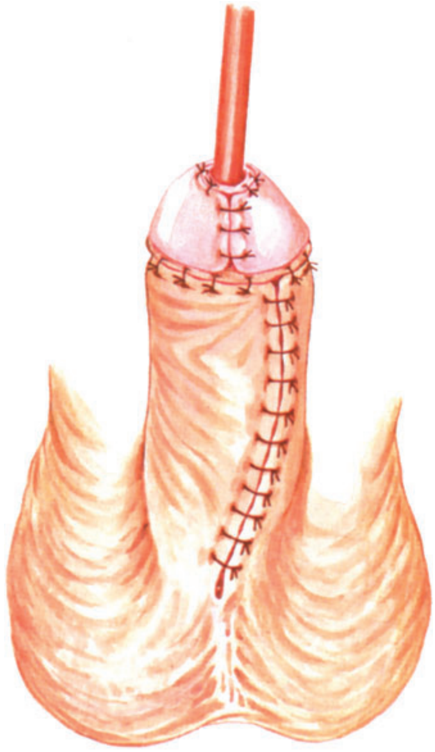
79-2. The oval skin flap around the proximal urethra is seen. The skin margins are separated, and skin hooks are placed at the distal corners. *The preputial skin, which has been measured around a 12–16 French catheter* (depending on age of the patient) *is incised transversely.* Note that the fibrous tissue representing chordee has been excised from a wide rectangular area. Hemostasis has also been meticulously controlled. *(Insert) The preputial skin is fashioned into a tube around the appropriate catheter,* with the raw surface on the outside.

79-3. *The proximal flap is formed into a tube by suturing the edges* (3-0 chromic catgut). The triangular flaps in the glans penis have been fashioned. Skin hooks assist in the dissection.

79-4. *The tubular skin graft is fitted into place and shortened if necessary.* The proximal anastomosis of tubular graft to urethra is made on a bias to widen the anastomotic site. The triangular flap of glans penis is placed proximally into part of the distal tubular graft, again to widen this distal anastomotic margin.

79-5. *The remaining triangular flaps of glans penis are brought around the stent and secured by sutures* (3-0 chromic catgut). The skin edges are reapproximated. The stent is removed after the compression dressing covered by elastic bandage has been secured around the penile shaft.



79-5

80. Marshall-Marchetti-Krantz Procedure

When a middle-aged female presents with stress incontinence, care must be taken to rule out other causes of urinary incontinence. Infection will cause an urgency incontinence coupled with frequency. Overflow incontinence must be excluded. Every attempt must be made to rule out the presence of a neurogenic bladder.

We routinely schedule each patient for urologic evaluation, obtaining a history and performing a physical examination. The presence of a cystocele and/or urethrocele is noted. Urinalysis will assist in ruling out urinary infection. If infection is present, then an intravenous pyelogram may be indicated.

We usually obtain a cystometrogram at the second office visit. In addition, we perform cystoscopy. If bladder capacity is normal, and stress incontinence is present, then we perform the Marshall test by refilling the bladder with 300 ml saline. We have been pleased with the voiding phase of the test performed in the upright position. The patient with a full bladder sits on the edge of the cystoscopy table with her lower extremities in the dependent sitting position. While the gloved hand raises the superior vesicourethral angle, the patient is urged to cough. This exercise is repeated after the pressure on the bladder neck is released. Selected patients who respond and become continent when the bladder neck is elevated are excellent candidates for the procedure.

If the middle-aged female patient has a cystocele, urethrocele, and a rectocele, then we refer her to the gynecologist for an anterior and posterior colporrhaphy.

The patient is placed in the lithotomy position and her lower legs are placed into stirrups. An alternative position can also be used. The knees are separated and the thighs are elevated on several long rolls. Access to the vagina is important during this procedure.

The skin in the suprapubic area is prepared in the usual manner. The vagina and introitus are also carefully prepared and cleansed with povidone-iodine (Betadine). After the wound has been draped, the bladder is filled with approximately 250 ml saline. The 18 French Foley catheter is left indwelling.

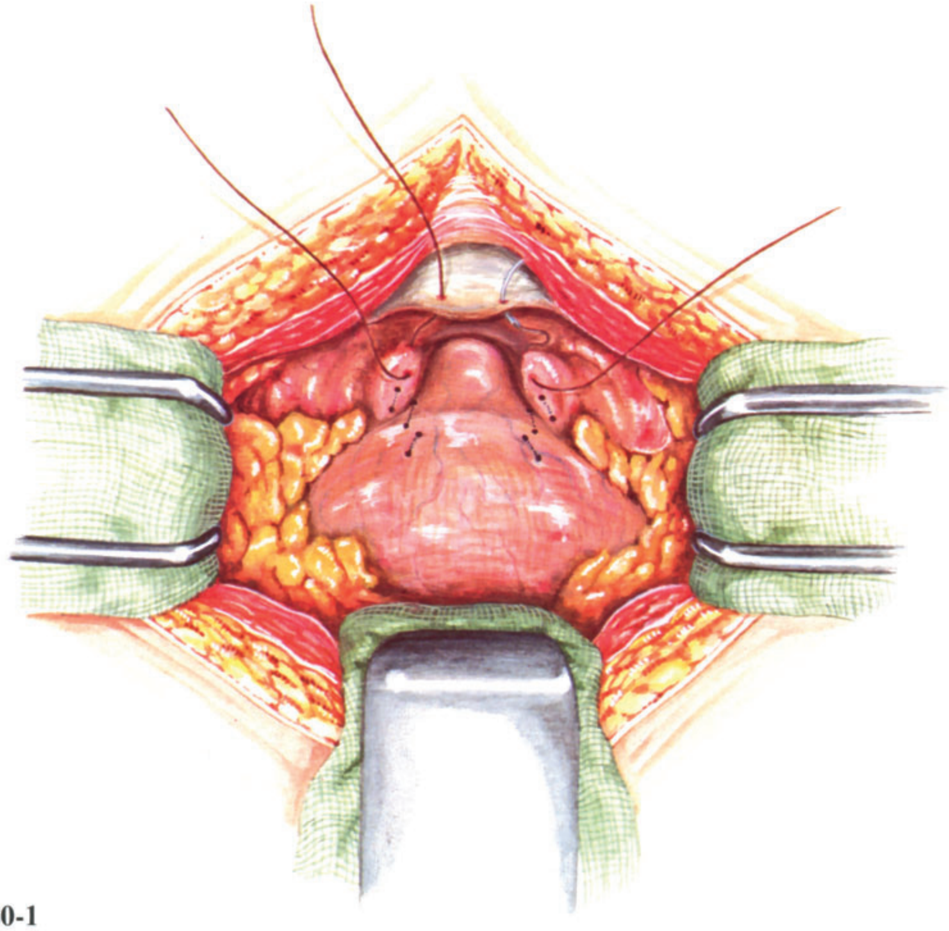
In an older patient a vertical midline incision may be used. We prefer a transverse skin incision in the younger or middle-aged patient.

The incision is made. Fascia is incised. Rectus abdominis muscles are separated from the vertical midline. The prevesical fat is removed from the anterior bladder and urethra.

80-1. *Four parallel pairs of 0 chromic catgut sutures elevate and reform the posterior vesicourethral angle.* The sutures are placed into the anterior vaginal wall lateral to urethra and left untied. The indwelling catheter assists in demarcating the location of the urethra and bladder neck. The first pair of sutures is placed approximately 1 cm inferior to the bladder neck and attached to the inferior periosteum covering the symphysis pubis. The second set of sutures is placed lateral to the bladder neck and into the periosteum, located more anteriorly and superiorly than the first set. These sutures also are not tied at this point. The third set of sutures is placed 1 cm superior to the bladder neck, and the sutures then enter the outer two-thirds of the bladder wall. The same sutures enter the periosteum still more anteriorly and superiorly. A fourth set of sutures is placed 2 cm superior to bladder neck and inserted into the rectus fascia on each side.

An assistant now places his index and middle finger into the vagina and elevates the bladder neck. The four pairs of sutures are tied and secured during this maneuver.

80-2. *A midsagittal view through the midbladder, symphysis pubis, and urethra.* The sutures have been placed and tied.



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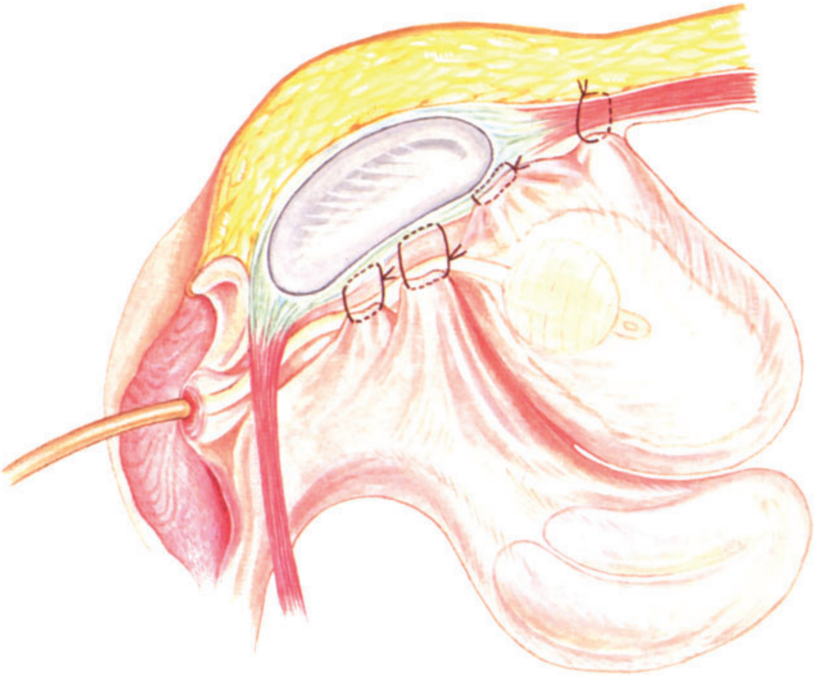


80-2

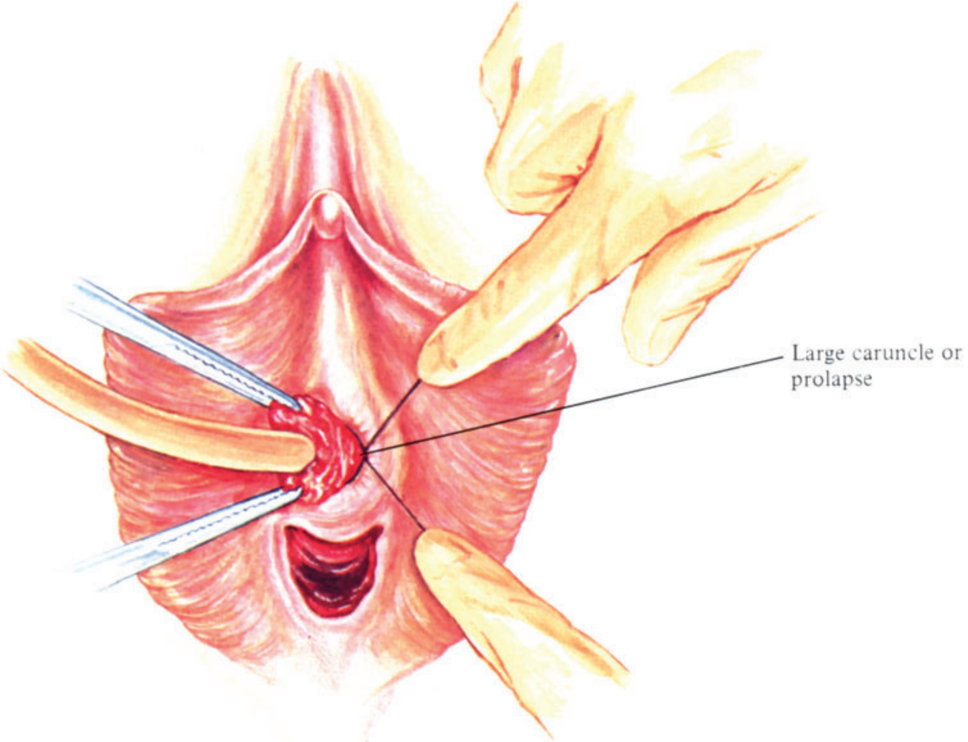
The catheter is left indwelling for 7 days. We close the wound in the usual fashion. If hemostasis is maintained, a Penrose drain is not needed. We usually place a vaginal pack deep into the vagina to assist in maintaining the proper bladder neck angle. The pack is removed after 36–48 hours. The patient is kept at bed rest for 7 days. Sulfonamides are given orally to maintain urinary asepsis.

81. Surgical Treatment of Urethral Disease in the Female

The patient is placed in a lithotomy position. Light anesthesia or local anesthesia is employed.

81-1. A urethral caruncle extrudes from and involves the distal urethra. *A urethral catheter (18 French Foley) is inserted,* and the bag is inflated. A guillotine tie is placed, proximal to the lesion, around the normal urethra. The lesion is grasped with forceps and the ligature (2-0 silk) is tightened.

81-2. *Removal of the catheter 2 days later* will usually include the urethral lesion.



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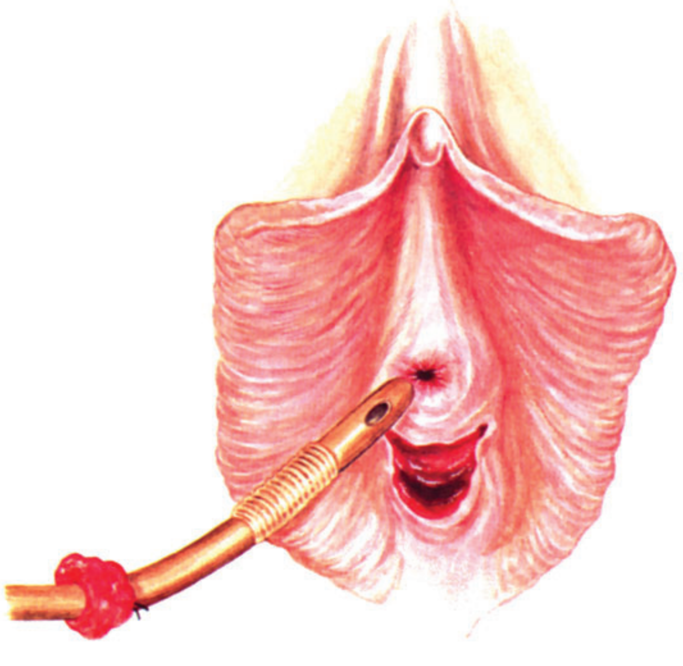


81-2

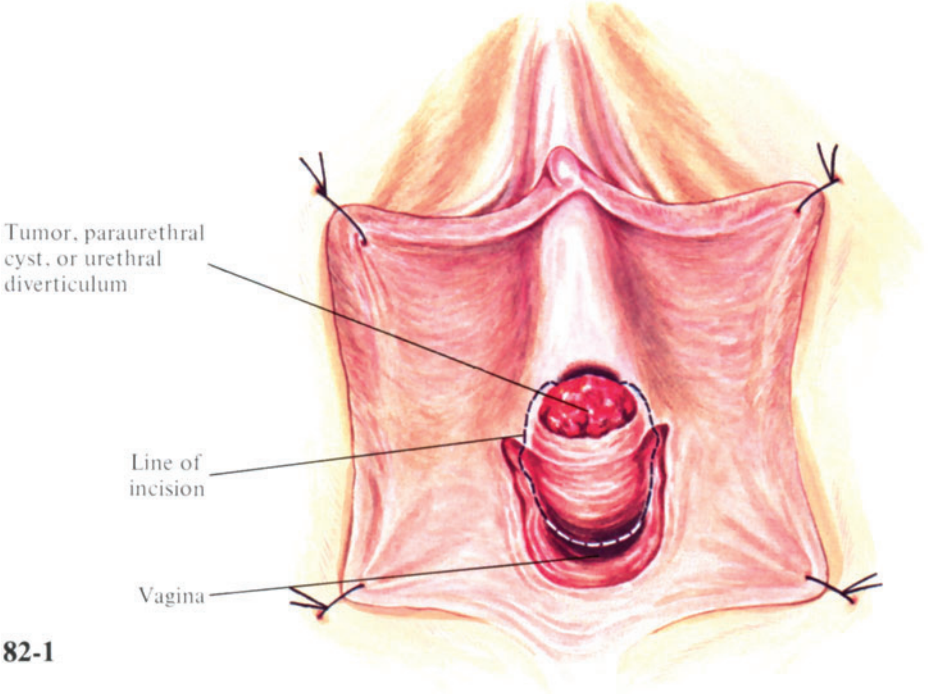
82. Removal of Distal or Mid-Urethral Lesions

A urethral diverticulum can be diagnosed at the time of pelvic examination. Careful elevation of the roof of the vagina overlying urethra, moving from a proximal to a distal direction, may produce a slight gush of purulent fluid. Fullness may also be palpated at times, but this is more difficult to corroborate. A urethrogram with a double balloon attachment can also assist in the diagnosis.

82-1. *The labial and vaginal edges are secured in each quadrant. The incision (dotted line) creates an anterior vaginal flap.* A weighted vaginal speculum is inserted to increase exposure.

82-2. *The lesion is removed* in this instance by means of cutting current.

82-3. *Reapproximation of the urethra and anterior vaginal wall* is completed in separate distinct layers; 3-0 chromic catgut is used. An indwelling catheter may be left for 4–6 days.



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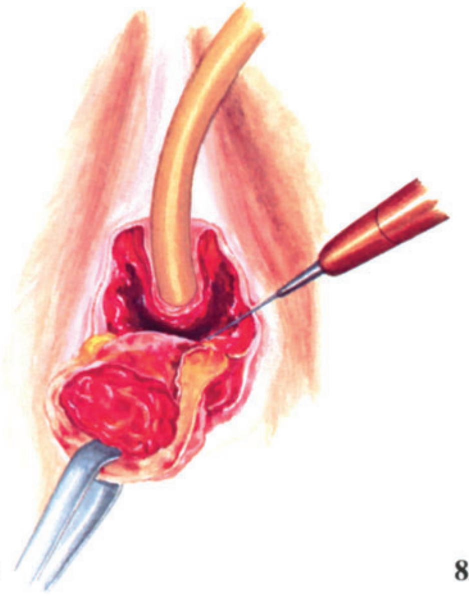

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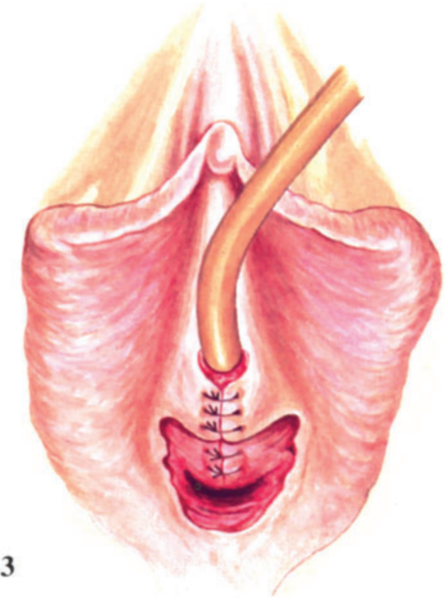

82-3

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The Penis

6

Surgical Anatomy

Structure

The penis is a pendulous, erectile organ with a posterior fixed root, and is supported by the suspensory ligament, an extension of the linea alba. The main erectile body of the penis is composed of three cylinder-like masses of cavernous tissue—the left and right cavernous bodies and the spongy body of the urethra (Fig. 1).

The cavernous bodies originate at the midportion of the ischiopubic rami, and firmly attach to the periosteum of the descending pubic rami and the inferior surface of the urogenital diaphragm. The bodies are united, side by side, in the body of the penis and have blunt ends at the base of the glans penis. At its root they are separated by the penile crura (Fig. 2). The perineal portion of the cavernous bodies is covered by ischiocavernous muscle, and the bulb of the urethra is covered by bulbocavernous muscle (Fig. 3).

The spongy body is slender and erectile and lies along the ventral groove of the paired cavernous bodies. Posteriorly, at the root, the spongy body expands to form the bulbous urethra, which is invested by bulbocavernous muscle. Anteriorly, at the end of the penis, the spongy body enlarges to form the glans penis and covers the ends of the cavernous bodies.

The spongy body serves as an envelope around the urethra from the urogenital diaphragm to the external urethral meatus, which opens at the glans. The glans penis is coated by a semimucous membrane rich in sebaceous glands and terminal nerve fibers.

Each erectile body is surrounded by a dense elastic connective tissue sheath called the tunica albuginea (white integument); trabeculas of this sheath surround the vascular spaces of the spongy structure.

All the penile bodies are invested together by a thin layer of Buck's fascia, which encases them from the base of glans to the root of the penis. It fuses the suspensory ligament and inferior surface of the urogenital diaphragm. Colle's fascia invests the penis between the skin and Buck's fascia and is continuous with the same layer of fascia over the perineum (Figs. 3 and 4).

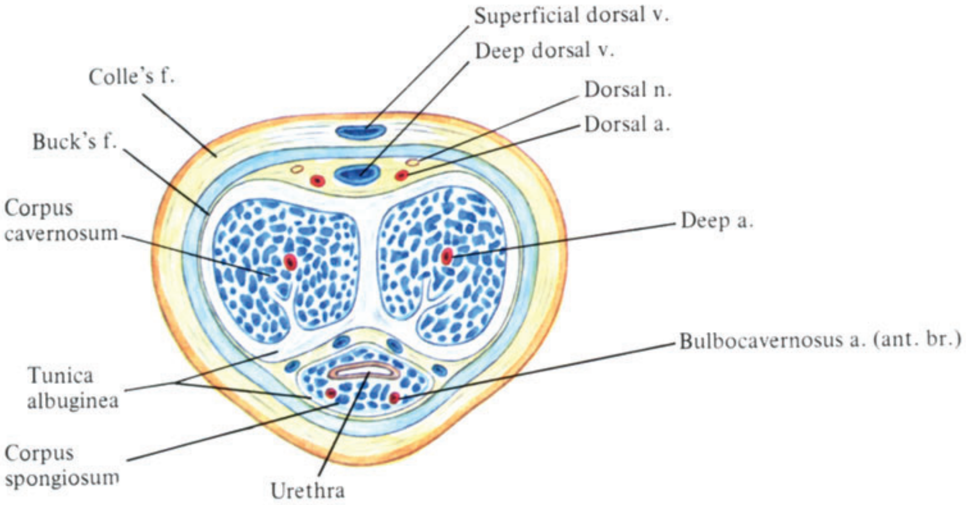


FIG. 1. Cross section of penis.

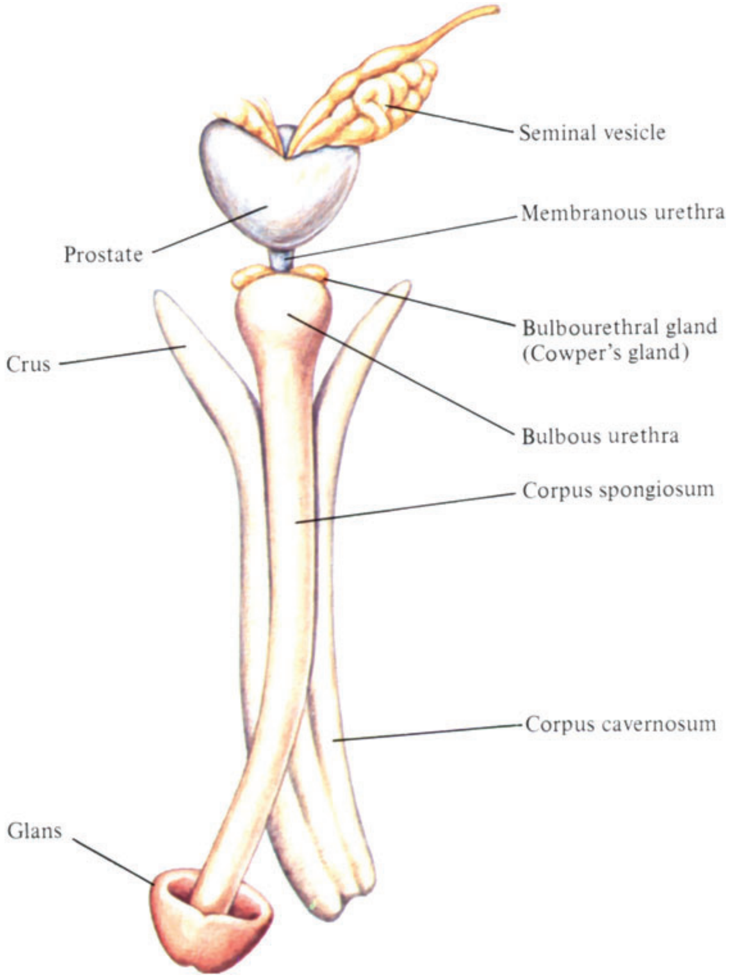


FIG. 2. Erectile bodies of penis.

The skin of the penis is thin and loosely attached to the underlying structures, and is devoid of adipose tissue and hair except at its base. It is continued forward as the prepuce (foreskin), which forms a cuff covering the glans. The internal surface of the prepuce is a semimucous membrane similar to that covering the glans and contains sebaceous glands which secrete smegma. On the ventral aspect of the glans, the frenulum, a well-defined median fold of skin, is attached from the lower angle of the urethral meatus to the prepuce. The frenulum contains a small artery, which may bleed profusely if transected during circumcision.

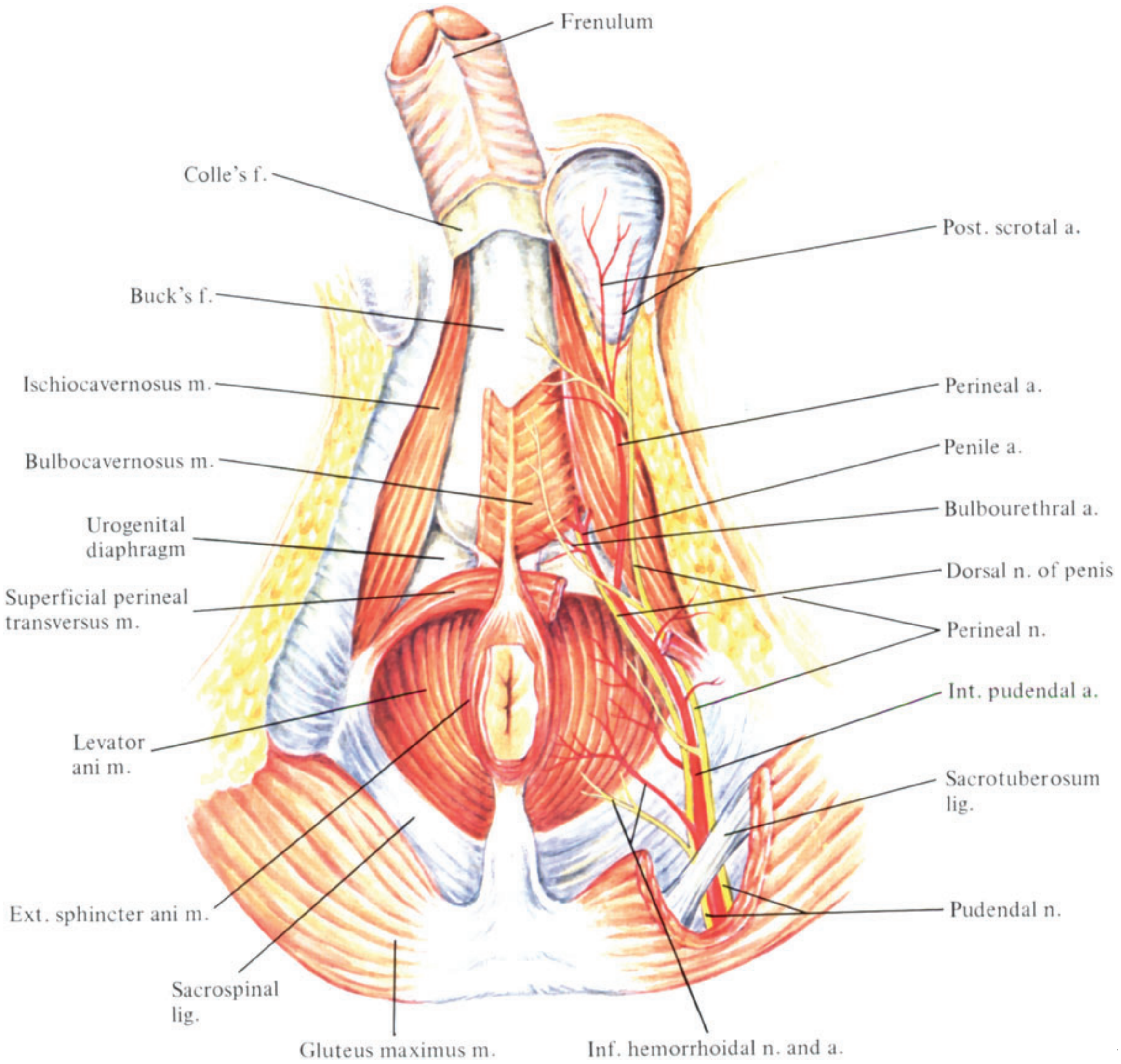


FIG. 3. Superficial structures of male perineum.

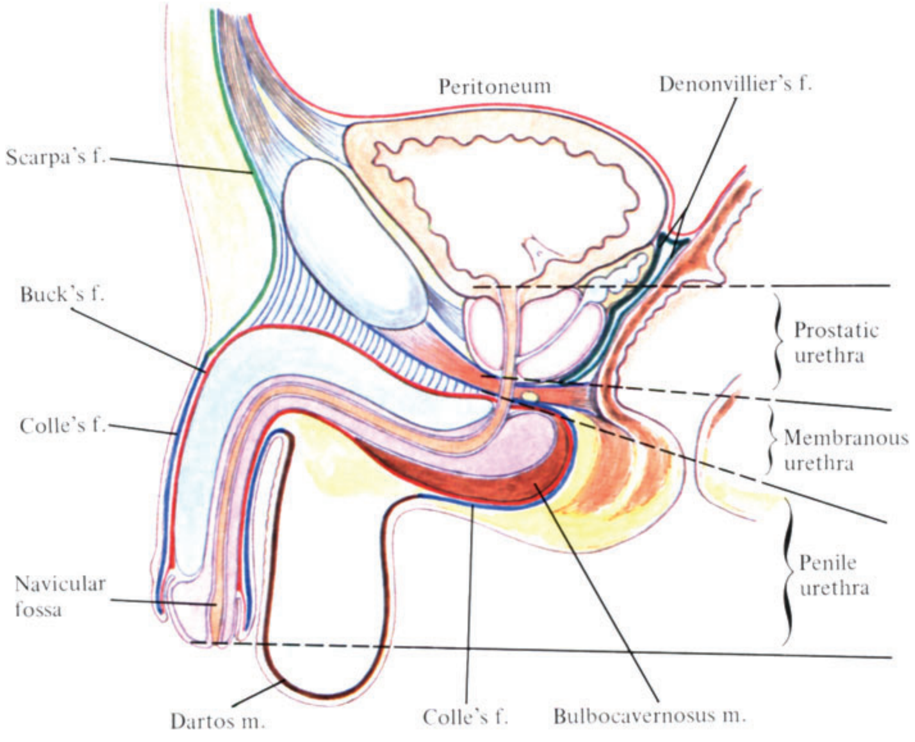


FIG. 4. Fascial coverings of male genital system and urethra, midsagittal section.

Vascular Supply

The arterial supply of the penis derives from internal pudendal artery. This artery divides into three paired branches at the base of the urogenital triangle, the dorsal, cavernous (deep), and bulbourethral arteries. The dorsal arteries of the penis course along the dorsal surface of the penile bodies between Buck's fascia and the tunica albuginea, one on each side of the deep dorsal vein. The dorsal nerve lies lateral to the artery. These arteries supply the body of the penis and terminate in the glans. The cavernous arteries pierce the medial aspect of each crus, distribute branches, and run forward in each cavernous body.

The bulbourethral arteries course along the urethra to the glans and there anastomose with the terminal branches of the dorsal arteries.

The veins of the penis comprise a superficial and a deep group. The superficial veins drain the prepuce and skin of the penis, form a network in the subcutaneous tissue, and empty into the superficial dorsal vein. The latter vein is easily seen through the skin. It runs proximally and terminates by dividing into right and left branches, which drain into the external pudendal veins in the thigh.

The deep dorsal vein begins at the base of the glans, courses proximally in the median line between Buck's fascia and the tunica albuginea and drains the glans and all cavernous bodies. It terminates by joining the venous plexus around the prostate (Fig. 5).

The lymphatics of the penis are divided into two main groups—superficial and deep. The superficial lymphatics from the skin of the penis join to larger lymphatic trunks that follow the dorsal vein of the penis and drain mainly into the external iliac nodes.

The deep lymphatics from the glans and the penile body drain into the deep inguinal nodes, medial femoral nodes (including the sentinel node) and also to external iliac nodes.

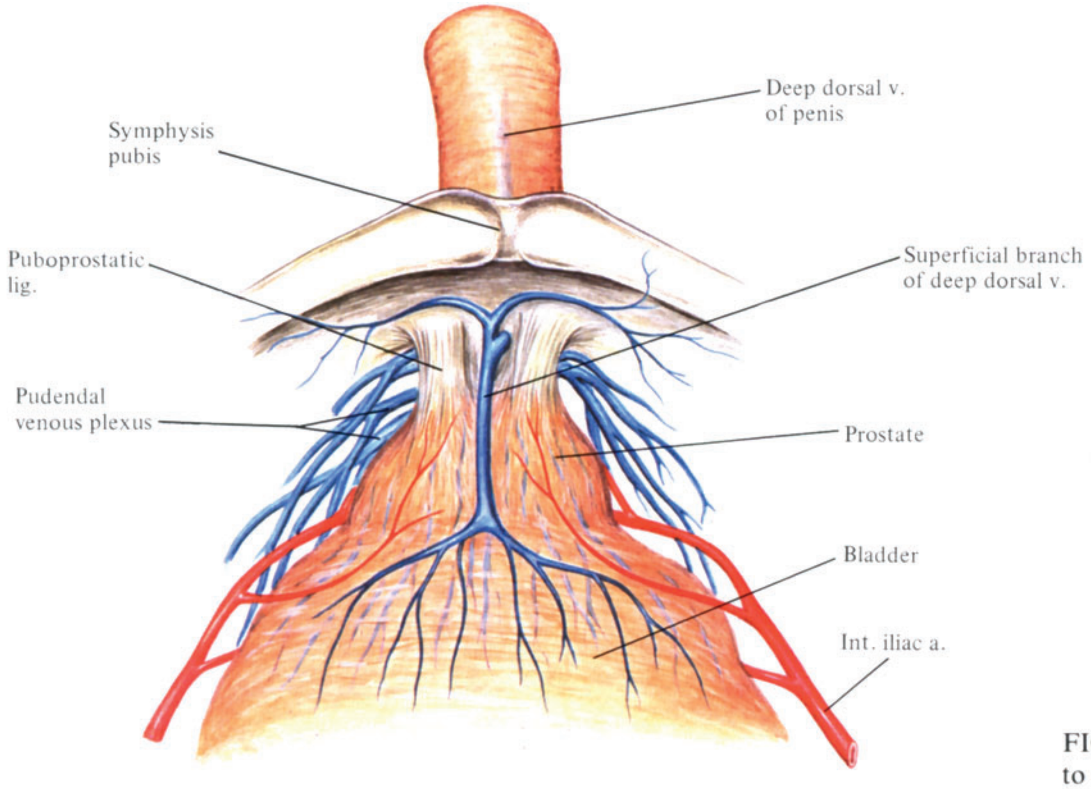


FIG. 5. Venous supply to prostate.

There are anastomoses also with the lymphatics of the bulbar and membranous urethra, which drain into the internal iliac nodes via the trunks accompanying the internal pudendal vessels.

Lymphatic drainage of the penis is of great importance in the management of penile malignancy (Fig. 6).

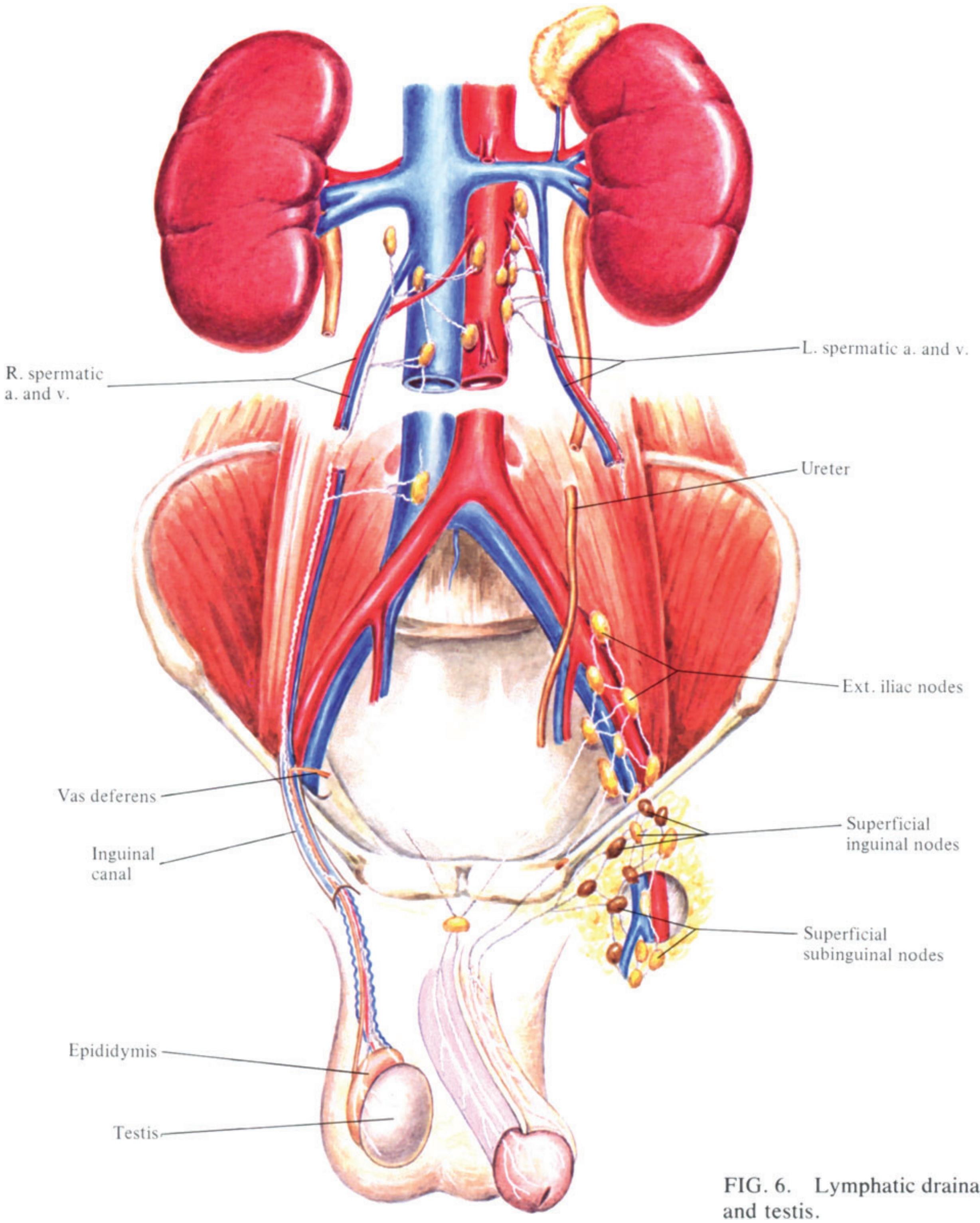


FIG. 6. Lymphatic drainage of penis and testis.

Nerve Supply

Sympathetic nerve fibers of the pelvic plexus are also distributed to the seminal vesicles, prostate, and urethra. The somatic innervation of the pudendal nerve distributes motor fibers to the external sphincter and perineal muscles and sensory fibers to the perineal tissues, urethra, and penis (Figs. 3 and 7).

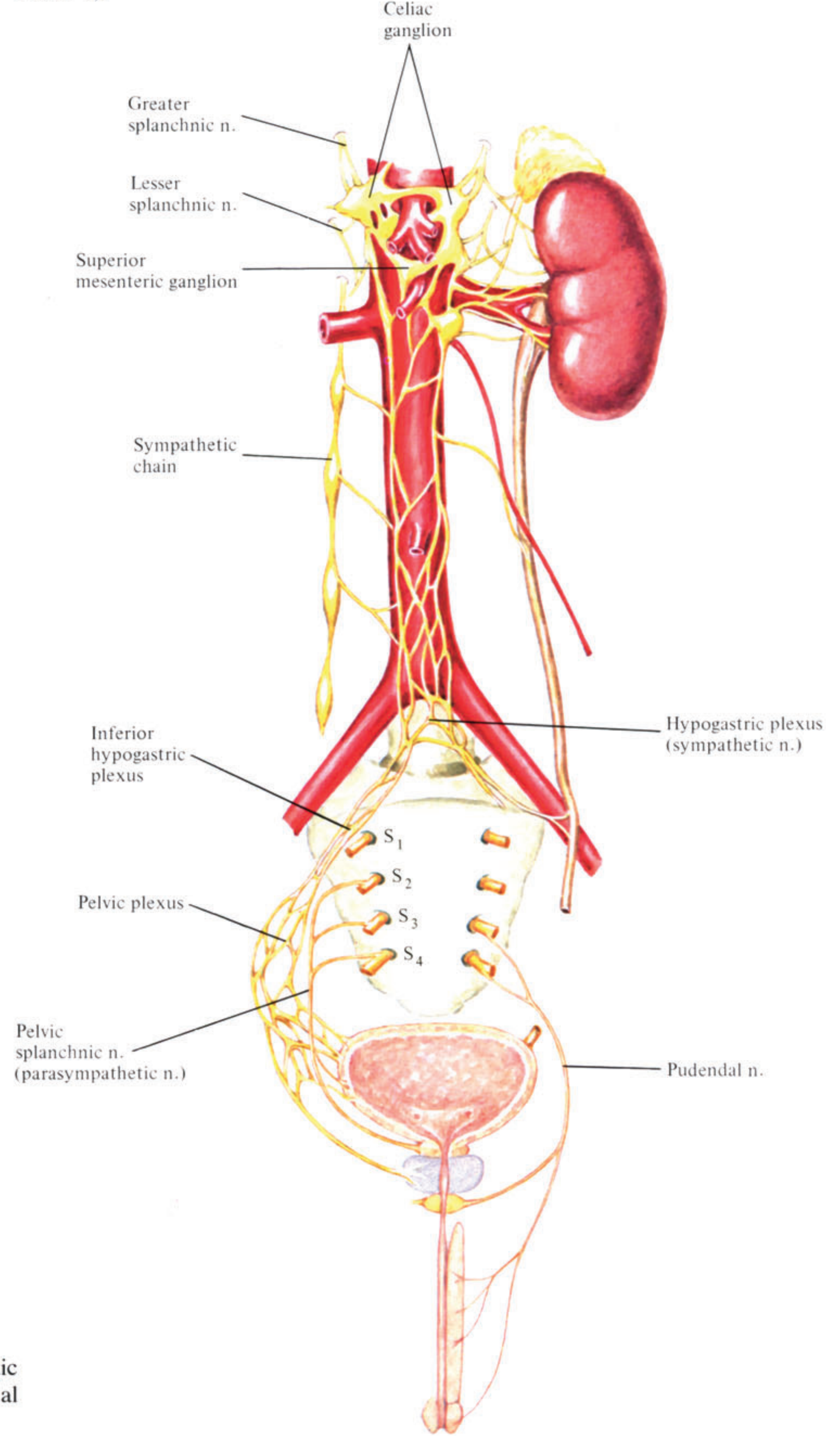

Celiac ganglion
Greater splanchnic n.
Lesser splanchnic n.
Superior mesenteric ganglion
Sympathetic chain
Inferior hypogastric plexus
Hypogastric plexus (sympathetic n.)
S_1
S_2
S_3
S_4
Pelvic plexus
Pelvic splanchnic n. (parasympathetic n.)
Pudendal n.

FIG. 7. Autonomic and somatic nerve supply to male urogenital system.

Operative Techniques

83. Circumcision

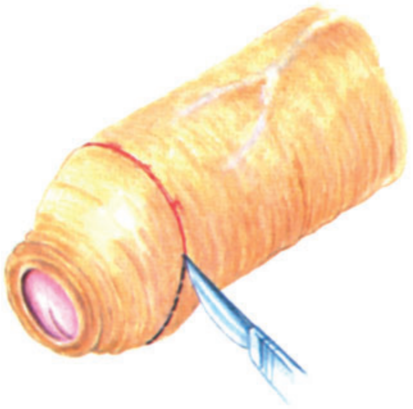
In the adult male this procedure can be performed under local anesthesia, or it may also be performed under general anesthesia as part of a short term admission.

83-1. The patient's penis and scrotal area are cleansed. *The redundant prepuce is incised* over the corona in a circumferential fashion.

83-2. *A dorsal incision can now be made to the site of the coronal incision.*

83-3. *Redundant foreskin is excised on the ventrum.* Care is taken to preserve some of the frenulum to allow a better cosmetic result.

83-4. Careful hemostasis must be maintained. We like the disposable, battery-operated coagulation device, which can be held in the hand and is widely available. *The skin edges are reapproximated with interrupted 3-0 chromic catgut sutures.*



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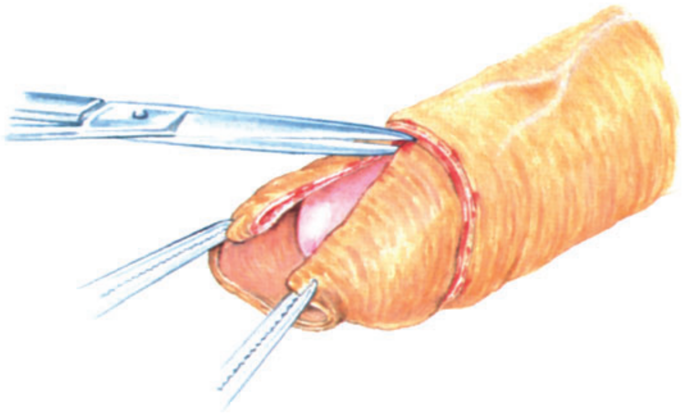

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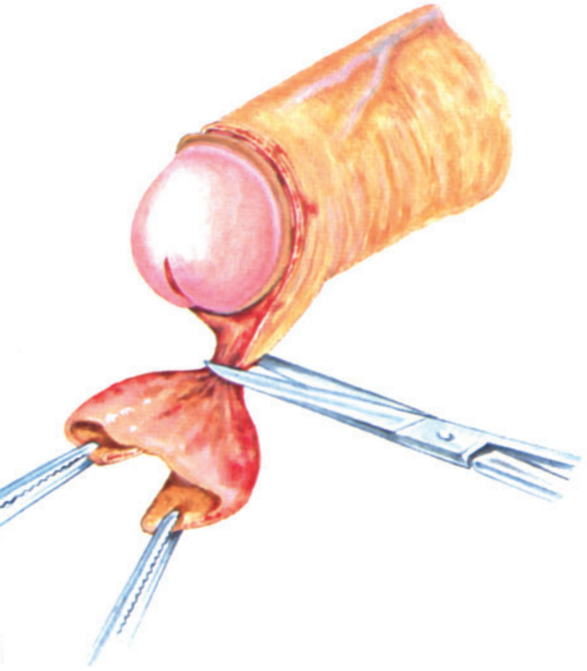

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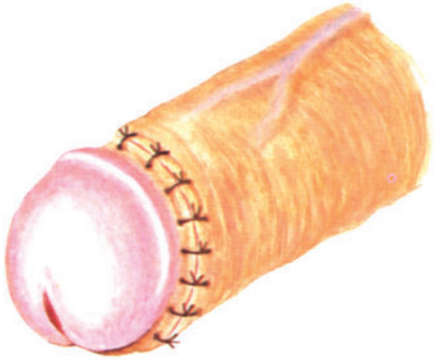

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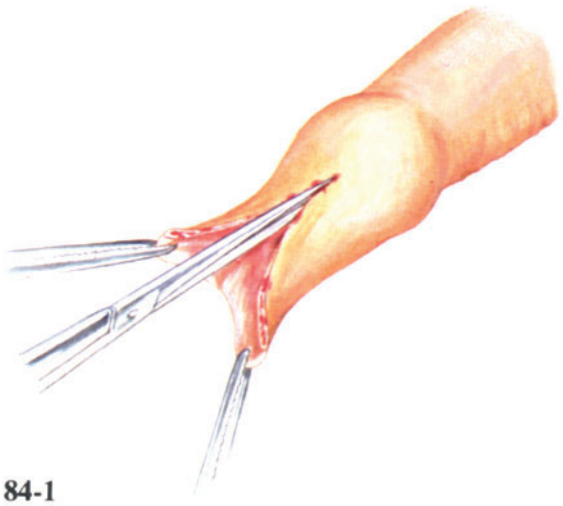
84. Circumcision in Infancy

Infant circumcision may be carried out within a day or two after birth if cultural custom so requires. The Yellin clamp helps to accomplish the procedure with ease and rapidity.

84-1. *A dorsal slit is made to the border just distal to coronal margin.* Retracting the prepuce on both sides by clamps is helpful.

84-2. The bell-shaped Yellin clamp comes in several sizes. *The proper-sized hollow Yellin clamp is placed over the glans penis.* Stay sutures assist in the procedure.

84-3. *The external attachment to the Yellin clamp is secured* with the hollow ringlike base placed over the lower margin of the bell-shaped internal attachment. *A circumferential incision is made.* We usually wait 10 minutes before releasing the clamp.



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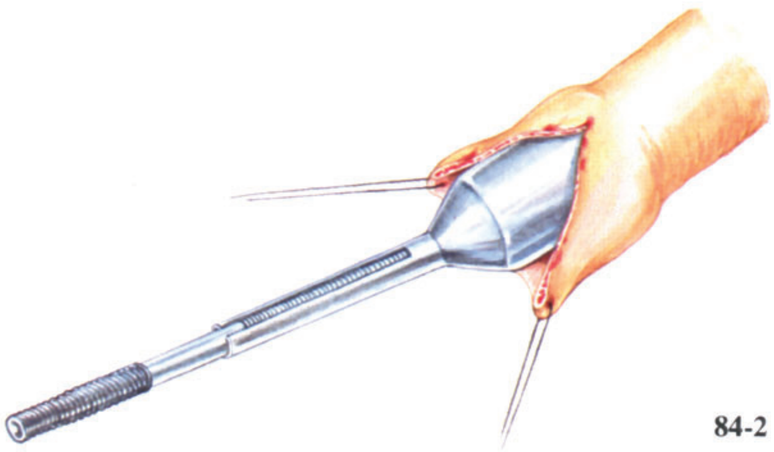

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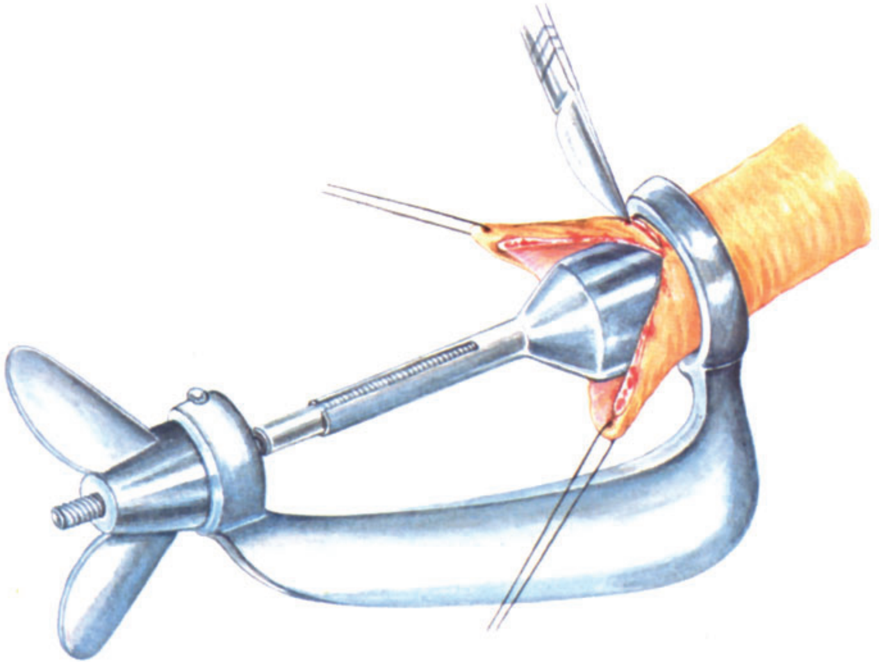

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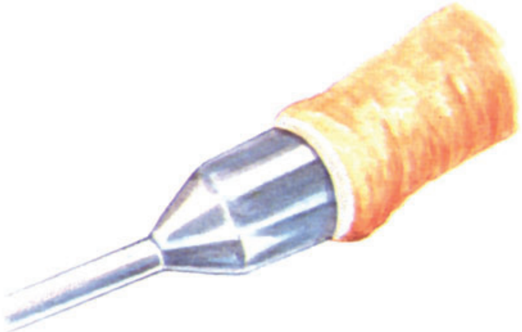

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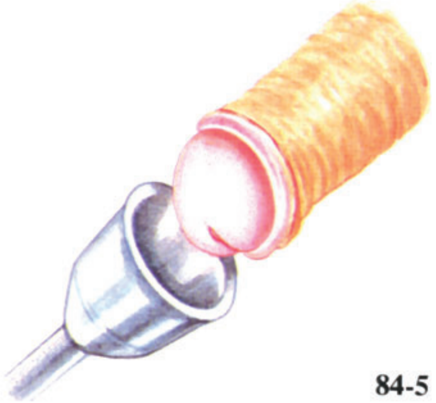


84-5

84-4. *Redundant prepuce is excised,* leaving an excellent sealed margin.

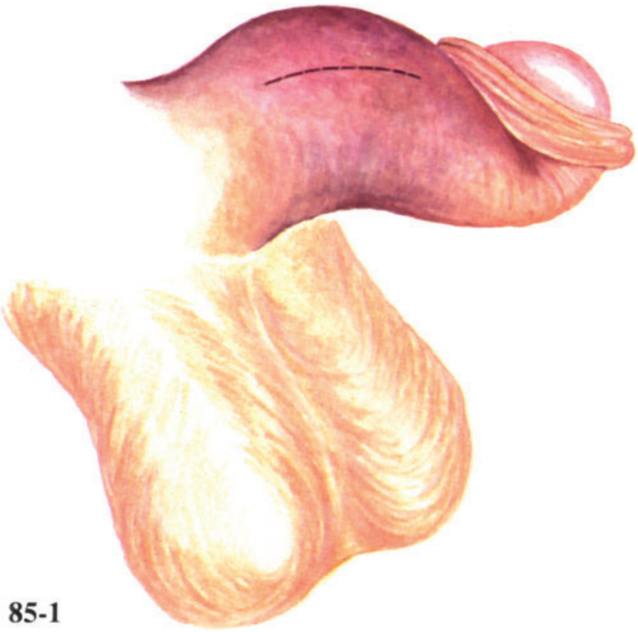
84-5. *The bell-shaped attachment is removed.* Hemostasis is not needed, and no sutures are required.

85. Trauma to the Penile Shaft[1,3]

The penile shaft may be injured from an external source during erection. Koshiba treated 5 cases in Japan and collected 56 other cases in Japan. The injury occurred most often in the second decade, and was noted following sexual intercourse or masturbation. The urethra was not injured. The patient usually complains of severe pain.

85-1. *A large hematoma forms at the ruptured area.* Forty-two of 56 cases underwent repair of the fascia and evacuation of the hematoma. Impotence was not a problem. Hemorrhage may be superficial beneath Colles' fascia but external to Buck's fascia. In the case illustrated trauma has been severe and hemorrhage extends beneath Buck's fascia (see Fig. 1).

85-2. The skin and Colles' fascia are incised. Buck's fascia is opened transversely and *the hemotoma is evacuated.* Hemorrhage is controlled. Chromic catgut sutures (3-0) are used to reapproximate the fascial edges. Skin hooks assist in exposure of the injured area.



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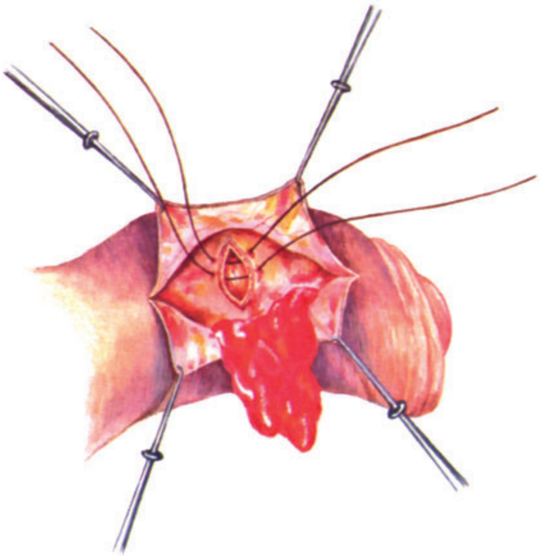

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86. Covering an Extensive Skin Defect of the Penile Shaft

This injury is seen frequently on the farm. The clothing covering penile skin may be entrapped in a conveyor type belt or wheel. Whenever possible, the denuded penis, and the testis when appropriate, should be covered with skin within 8–10 hours.

Split-thickness skin grafts are an acceptable method for covering the defect caused by avulsion of the penile skin. The injured area must be cleansed and debrided thoroughly. Dirt and hair are removed. Hematomas are incised and removed. We have found the inner thigh skin area to be a useful donor site (the skin graft is 0.02 inches thick).

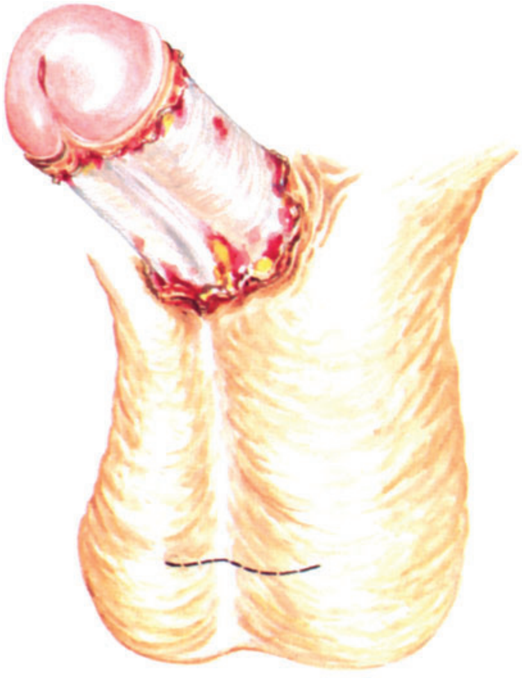
An alternative can also be employed, as follows.

86-1. *The penile shaft is debrided,* and hemostasis is achieved. The scrotal skin appears healthy. The incision (dotted line) will serve to create the new collar of tissue around the corona of the penis. The subcutaneous scrotal skin can be tunneled to allow the penis to be buried.

86-2. *The corona of the penis is approximated to scrotal skin,* and the defect in the anterior superior scrotal area is reapproximated. At least several months are allowed for healing to take place.

86-3. *The new scrotal skin to be used in covering penile shaft is outlined.* Stay sutures can be placed at the inferior corners to improve the surgeon's orientation.

86-4. *The penis and attached scrotal skin are released.* The skin margins and the inferior scrotal skin are reapproximated. As an alternative, the scrotal skin margins at the penoscrotal junction can be closed transversely if that approach is deemed appropriate.



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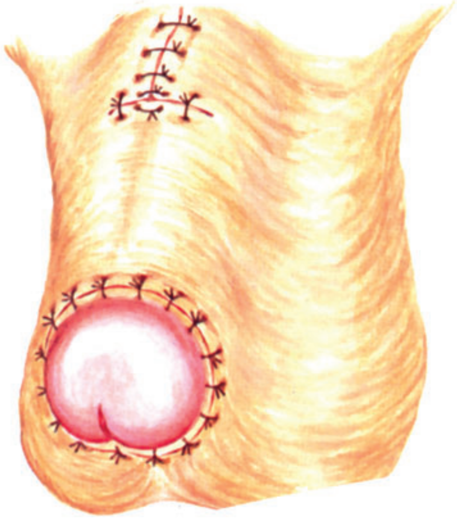

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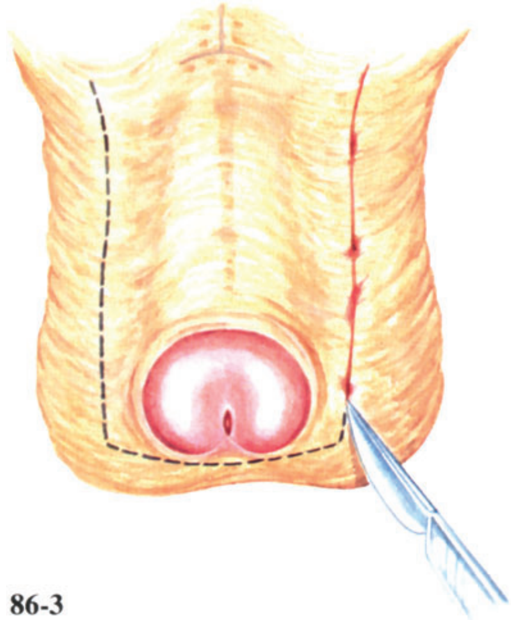

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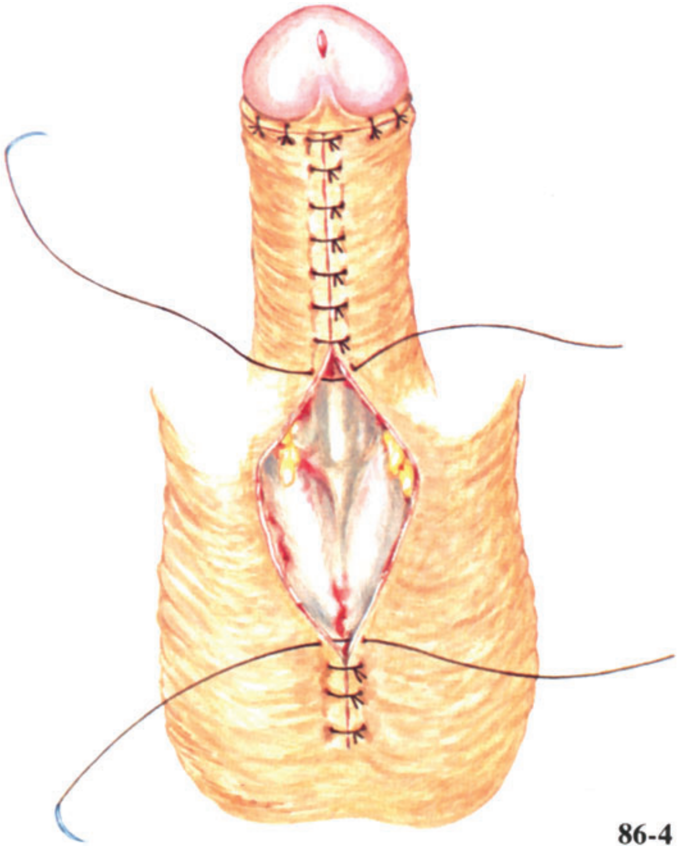


86-4

Correction of Priapism and Organic Impotency

Priapism is a condition characterized by abnormally prolonged and distressing erection of the penis. It is usually painful to have intercourse with priapism. The commonest cause in the black male is a sickle-cell disorder. Priapism rarely resolves spontaneously. Medical or surgical measures are needed to treat this condition.

Priapism is relatively infrequent. Those seeking more detail on the pathophysiology of this condition are referred to the studies by Farrer and Goodwin[2] and by Winter.[5]

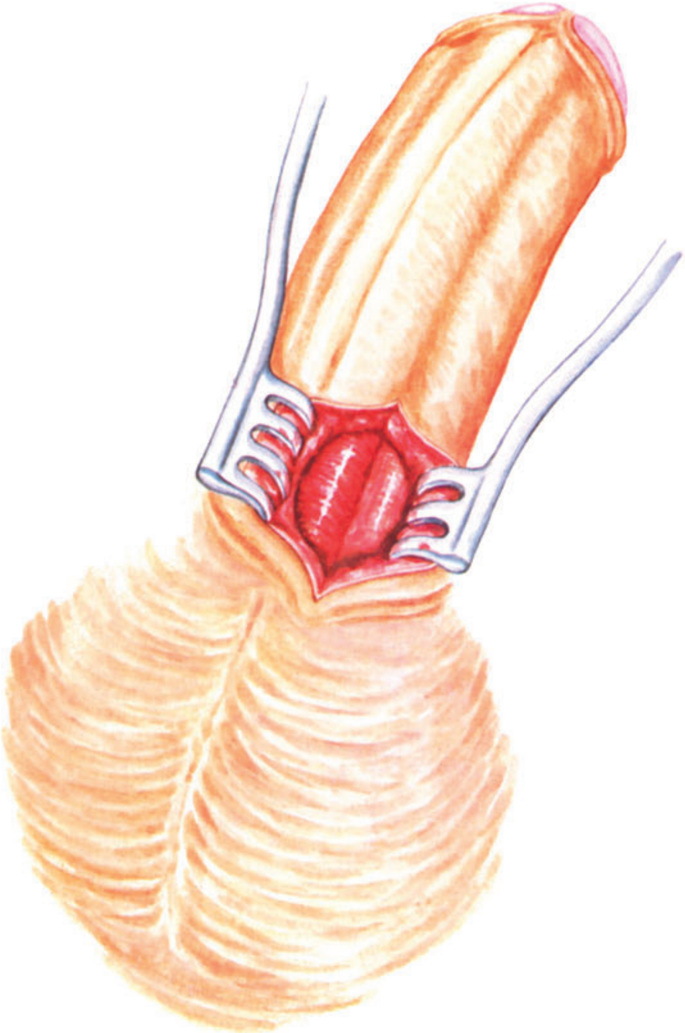
87. Anastomosis of the Cavernous Body to the Spongy Body

87-1. A new, highly successful procedure consists of creating two oval windows—one in the cavernous body and a second lying in apposition, in the spongy body. *Both erectile bodies are prepared and dissected.* They are still covered by fascia.

87-2. *It is important that a running suture (3-0 chromic catgut) be placed between the fascia of both bodies.*

87-3. *Oval windows are fashioned* by removing the fascial walls in both bodies, and both bodies are vigorously irrigated to remove clot.

87-4. *Side-to-side anastomosis is completed* with a running 3-0 chromic catgut suture. The skin and subcutaneous tissue are reapproximated in the usual fashion.



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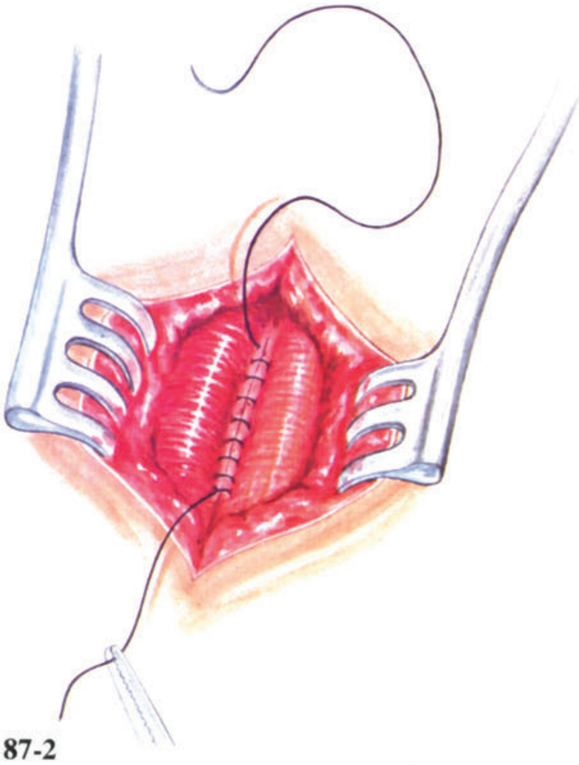

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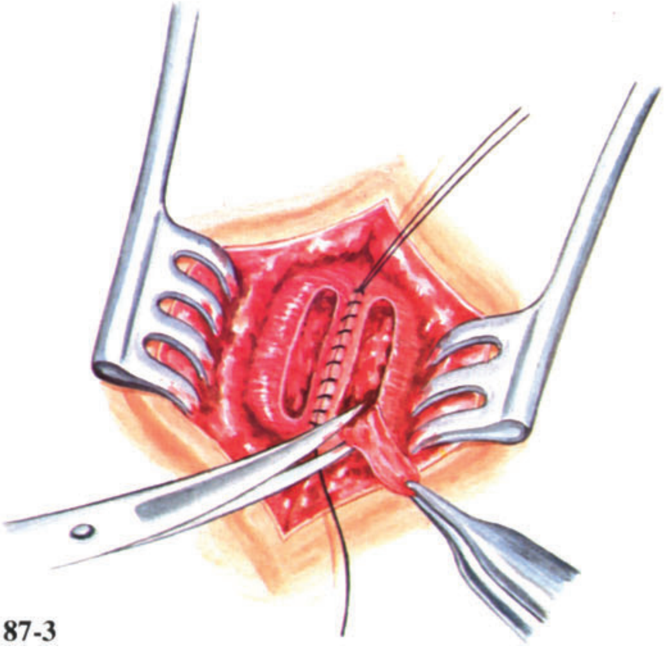

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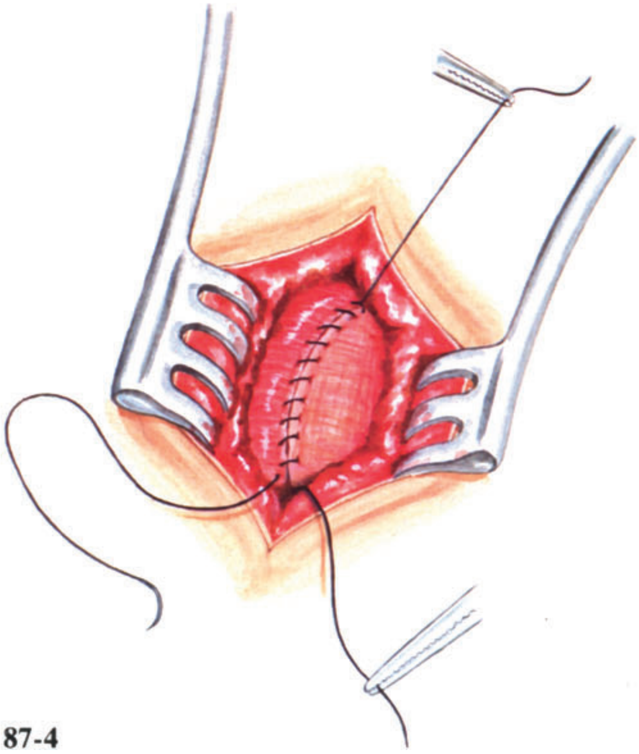

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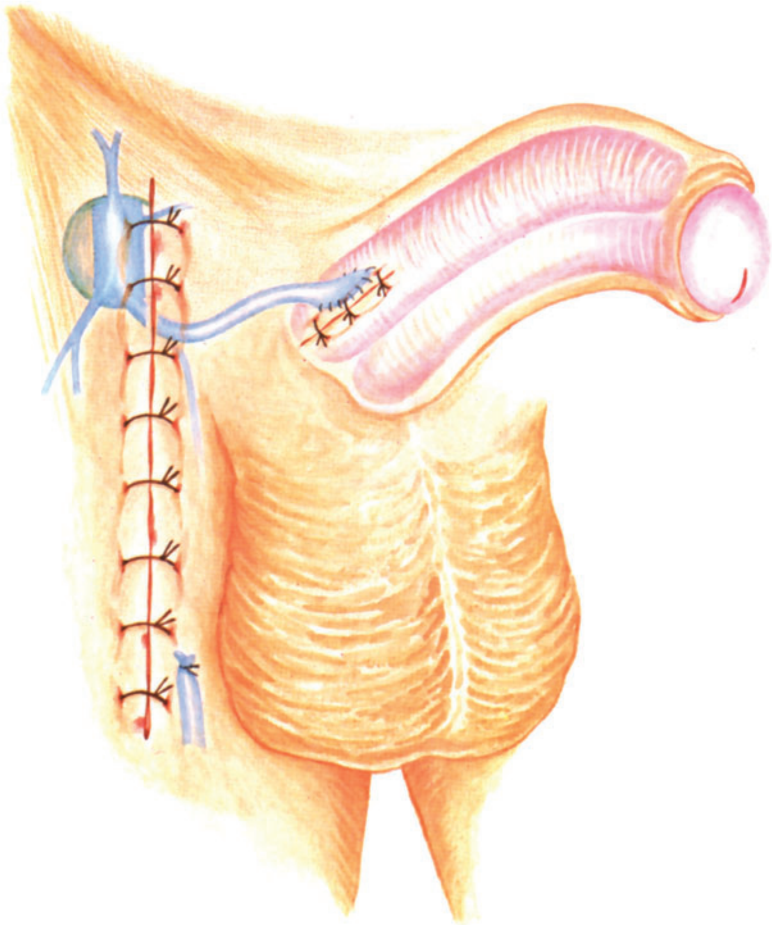
88. Anastomosis of the Right Saphenous Vein to the Cavernous Body

88-1. Two incisions are necessary in this procedure. *The saphenous vein is isolated, and the distal margin is ligated.* Approximately 6–8 cm of vein is freed. A tunnel is made beneath the skin to allow the vein to reach the base of the penis. The lateral aspect of the cavernous body is dissected, exposing the fascial covering. An end-to-side anastomosis of vein to the cavernous body is made. Closure of both wounds is by layers in the usual fashion. A bilateral saphenous-vein-to-cavernous-body procedure is sometimes indicated.

89. Correction of Organic Impotency

A silicone rubber prosthesis is inserted into the cavernous body (Small-Carrion[4] procedure) bilaterally.

Candidates for this procedure have organic impotency. Patients who have undergone radical perineal prostatectomy or total cystectomy and prostatectomy are candidates. Selected patients with diabetes mellitus and impotency are also good candidates. We have seen a few neurologic disorders causing impotency, and the procedure using the prosthesis is indicated for these few patients, as well as for those in whom trauma or priapism resulted in impotency.



88-1

The patient is placed into the slightly exaggerated lithotomy position and prepared and draped to allow adequate exposure of the perineum. We keep all lengths of the paired prosthetic rods with the tapered curved ends (see Fig. 89-5). After an appropriate pair of rods has been selected, we soak the silicone rubber prosthesis in an erythromycin solution (1 g in 500 ml saline).

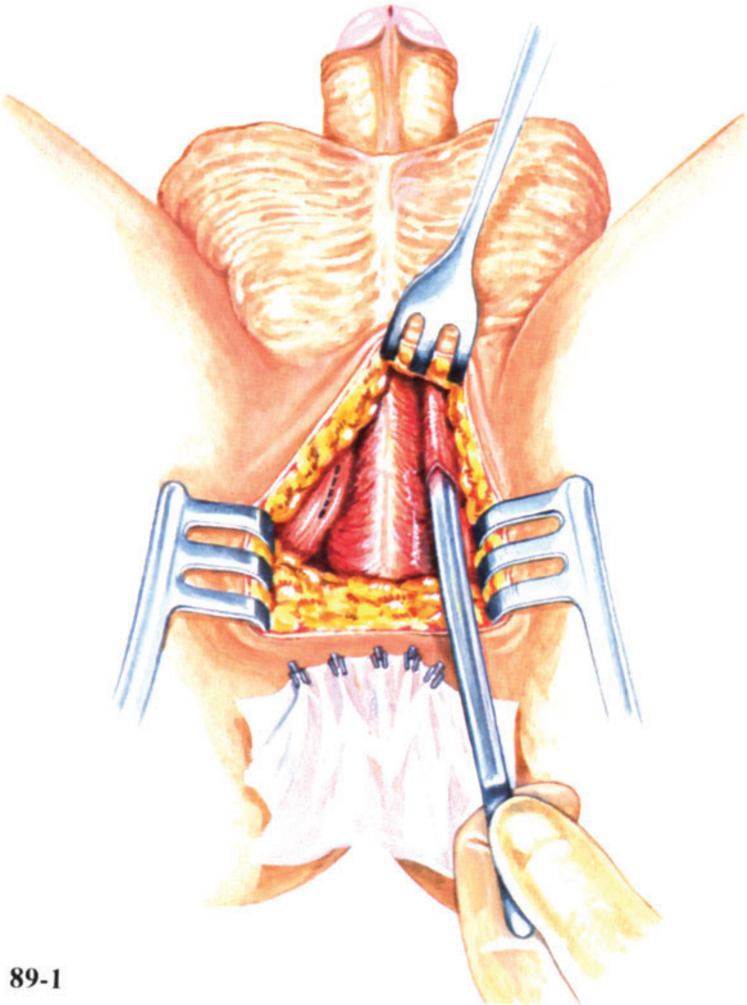
89-1. *A vertical skin incision is made from a point inferior to the scrotal perineal junction* and extends for 6–8 cm. A sound (24 French) is passed into the urethra and bladder to help identify the bulbous urethra.

The bulbocavernous muscle overlying the urethra is carefully exposed. The connective tissue overlying each ischiocavernous muscle is freed and wiped laterally, exposing the fascial covering.

A longitudinal incision is made through the fascial layer of ischiocavernous muscle, exposing the interior of the cavernous bodies. Stay sutures are placed to keep the fascial margins separated. This incision is approximately 4–6 cm superior to the ischial tuberosity on the right.

Hegar dilators are then inserted (gradually increasing sizes from 8 to 16 French are used) to dilate the cavernous bodies from the incision to their distal ends at the coronal penile margin.

89-2. The dilator is also reversed in its direction so that the inferior proximal cavernous body is also dilated. The procedure is repeated on the opposite side.



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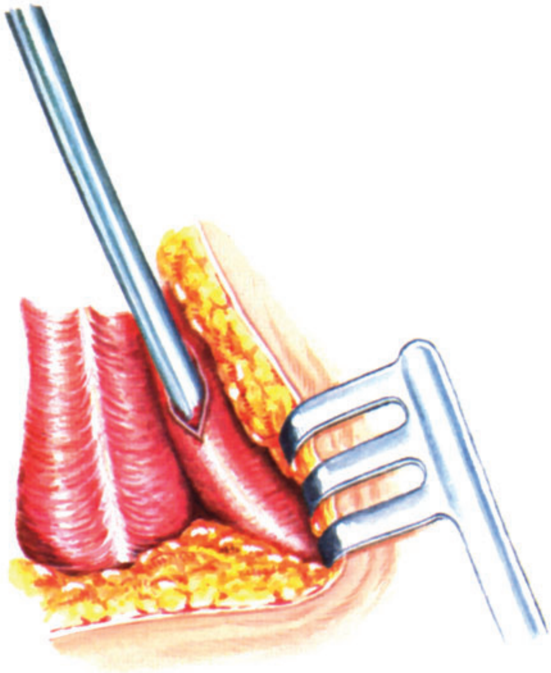

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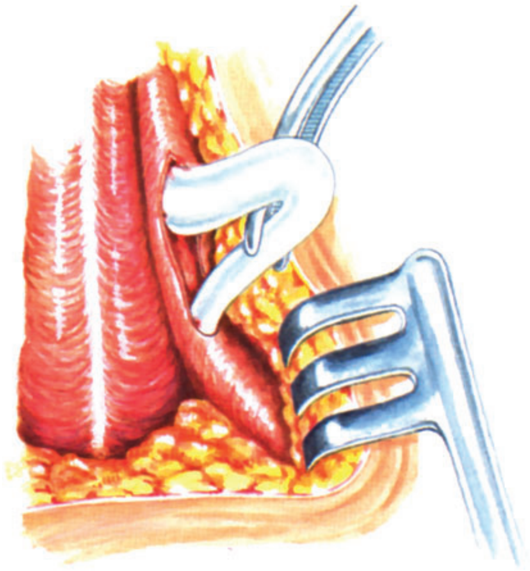
89-3. The surgeon can usually determine the appropriate prosthetic length and diameter of the shaft after dilatations have been completed. The *appropriate silicone rubber rod is selected and inserted.* The distal tip should rest against the glans penis, slightly raising the glans. The tapered narrower end is inserted pointing toward the ischial tuberosity.

89-4. *The fascial layers are reapproximated with 3-0 chromic catgut.* We usually leave a urethral indwelling catheter (16 French) in the bladder for 24 hours.

89-5. *The paired silicone rubber rods are checked for proper alignment and position.* Note the slight groove under the glans penis. Note also that the tapered curved posterior ends point toward the ischial tuberosity.



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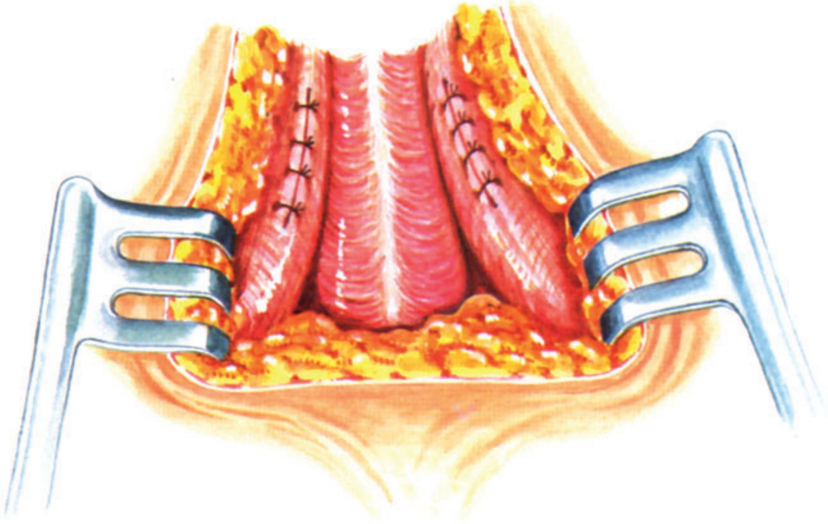

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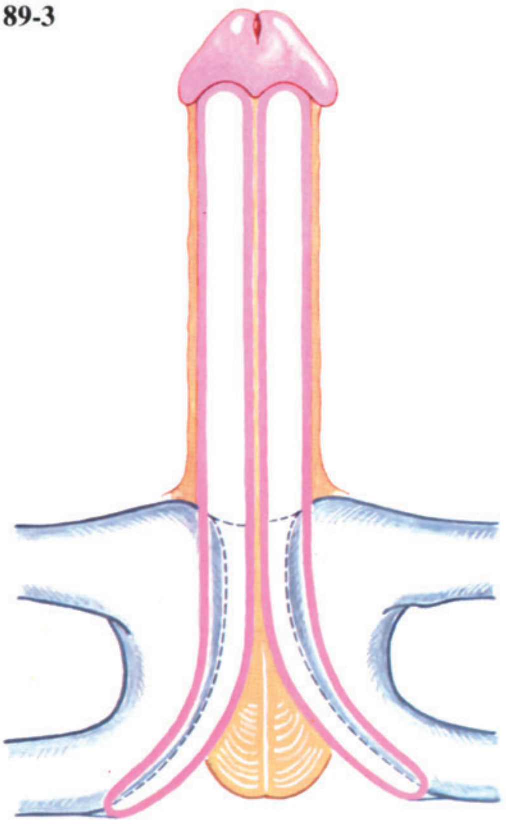

89-5

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2. Farrer JR, Goodwin WE (1961) Treatment of priapism: comparison of method in fifteen cases. J Urol 86:768
3. Meares EM Jr (1971) Traumatic rupture of the corpus cavernosum. J Urol 105:407
4. Small MP, Carrion HM, Gordon JA (1975) Small-Carrion penile prosthesis. Urology 5:479
5. Winter CC (1975) Priapism. In Glenn JF (ed) Urologic Surgery. Harper & Row, Hagerstown

The Scrotum and Its Contents

7

Surgical Anatomy

Structure of the Scrotum

The scrotum is a contractile cutaneous pouch containing the testes and the inferior part of the spermatic cords. It has a bilateral origin; the left and right scrotum are fused together in the midline forming the median raphe. This septum divides the scrotal cavity into two compartments. The scrotal wall consists of skin, muscle, and connective tissue. The skin of the scrotum is thin and elastic and usually lies in folds. It is deeply pigmented and contains many sebaceous glands and hair follicles.

Immediately beneath the skin is the dartos tunic, a thin layer of involuntary muscle and connective tissue that contracts with cold and relaxes with heat. It is supplied with sympathetic nerve fibers. Anteriorly it is continuous with the superficial fascia of the abdominal wall; laterally it is attached to ischiopubic rami; and posteriorly it is prolonged into the superficial perineal fascia of Colles.

A layer of loose connective tissue lies between the dartos layer and the deeper layers. The tissue is sufficiently loose to permit the scrotal contents to move about freely in the scrotal cavity. This layer presents a good plane of cleavage when the scrotum is being approached surgically. It is in this loose layer that extravasations and hematomas from the perineal region accumulate; the layer may spread superiorly under Scarpa's fascia and the superficial fascia of abdominal wall.

Besides the above three layers, there are another three complete layers that invest the testis and cord. All of them are derived from the anterior abdominal wall.

The most superficial is the external spermatic fascia, an extension of the external oblique fascia.

The middle layer is the cremaster muscle layer, which is derived from internal oblique muscle. By contraction of this layer, the testis is drawn toward external inguinal ring. The cremasteric reflex is produced by the strong contraction of these muscle fibers if the skin of medial thigh is scratched.

The deepest is internal spermatic fascia, an extension of the transversalis fascia. It is composed of loose connective tissue and closely invests elements of the spermatic cord and testis.

The tunica vaginalis of the testis is a serous membrane that covers most of testis and epididymis. Developmentally it is derived from the vaginal process of the peritoneum. The remainder of the funicular portion of the process, the vaginal ligament, lies among elements of spermatic cord from the internal inguinal ring to the tunica vaginalis. Like all other serous membranes, it forms a cavity which contains a film of fluid, and it divides the tunica vaginalis into parietal and visceral layers. The parietal layer is closely adherent to the internal spermatic fascia. It reflects forward at the posterior wall of the scrotum and becomes continuous with the visceral layer, which is closely adherent to tunica albuginea, the fibrous covering of the testis and epididymis (Figs. 1 and 2).

Structure of the Testis, Epididymis, and Spermatic Cord

The testis is a paired oval glandular organ, which lies in either side of scrotal cavity. It is loosely suspended by the spermatic cord and its investing tunic layers. It is also attached to the base of the scrotum by the gubernaculum.

The testis is coated by a pearly white fibrous layer, the tunica albuginea. It becomes thicker at the posterior border, forming the mediastinal testis, from which numerous incomplete fibrous septums pass inward to subdivide the testis into many lobules. Each lobule of the testis is filled with convoluted seminiferous tubules; the proximal end unites with the ends of other lobules to form a network called the rete testis at the mediastinal testis. From this network about 20 efferent ductules arise and enter the head of the epididymis from the upper pole of the testis (Fig. 3).

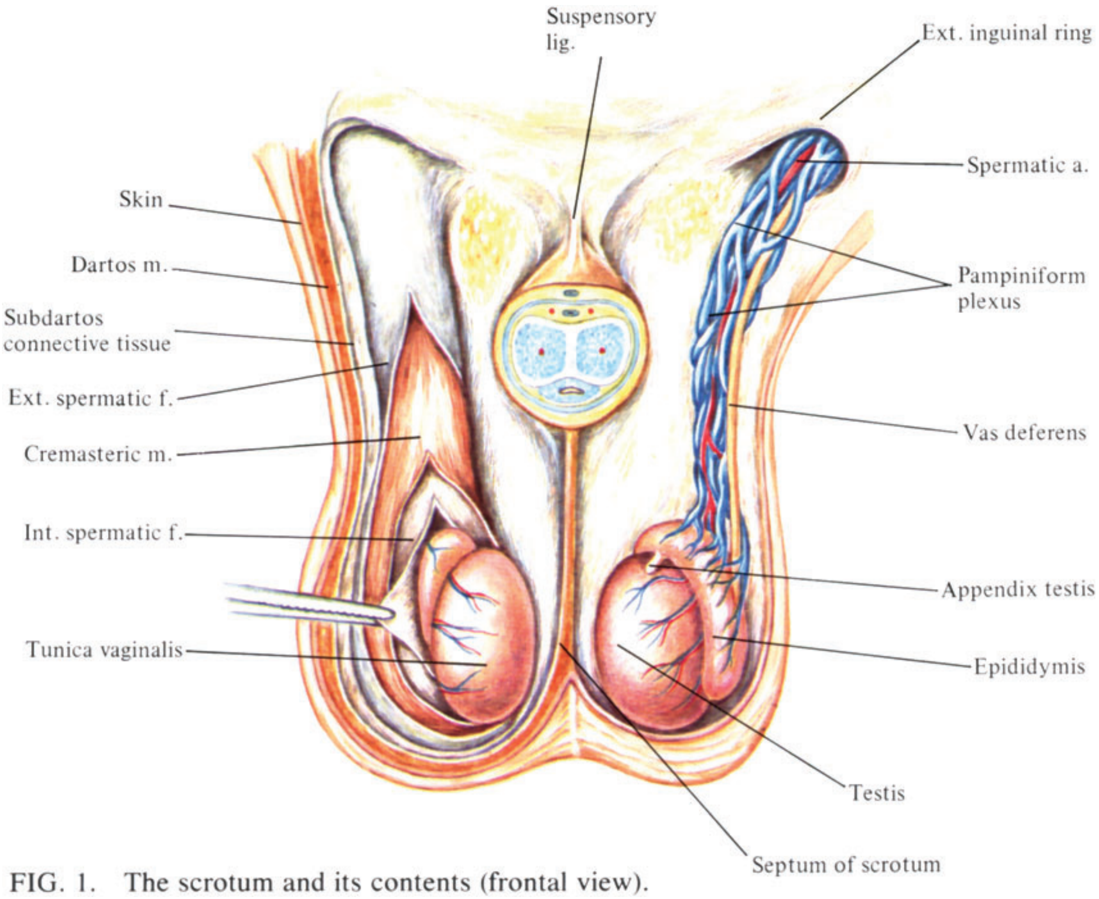


FIG. 1. The scrotum and its contents (frontal view).

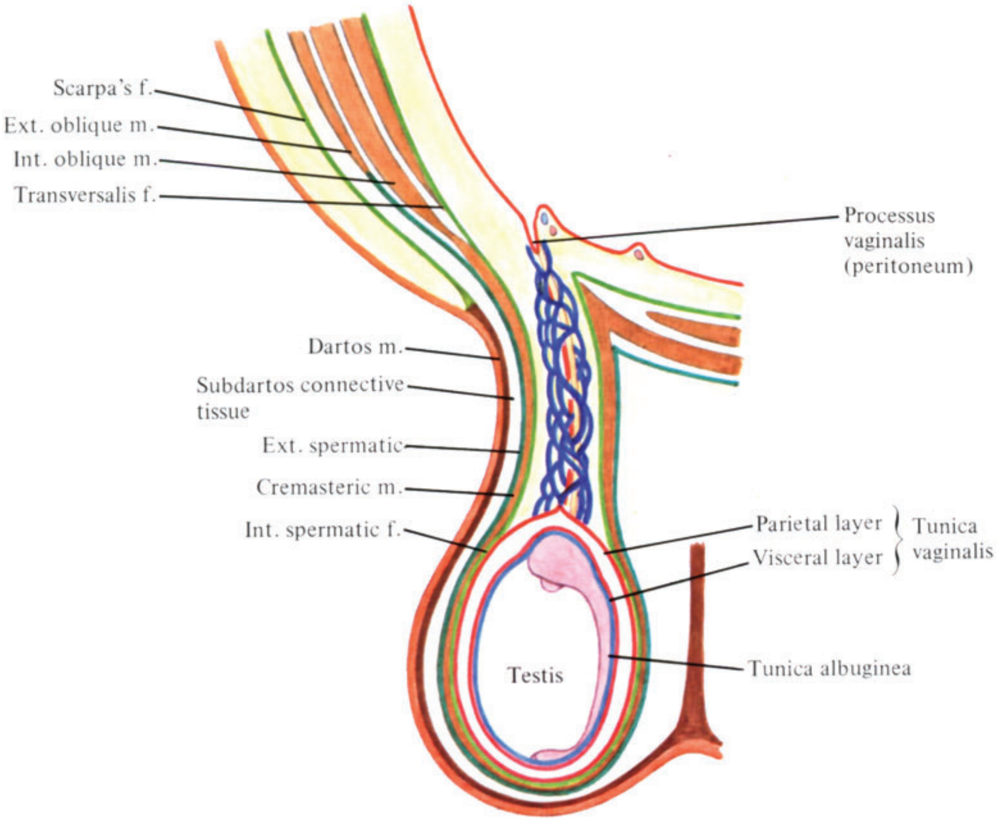


FIG. 2. The scrotum and inguinal region (schematic of frontal view, right half).

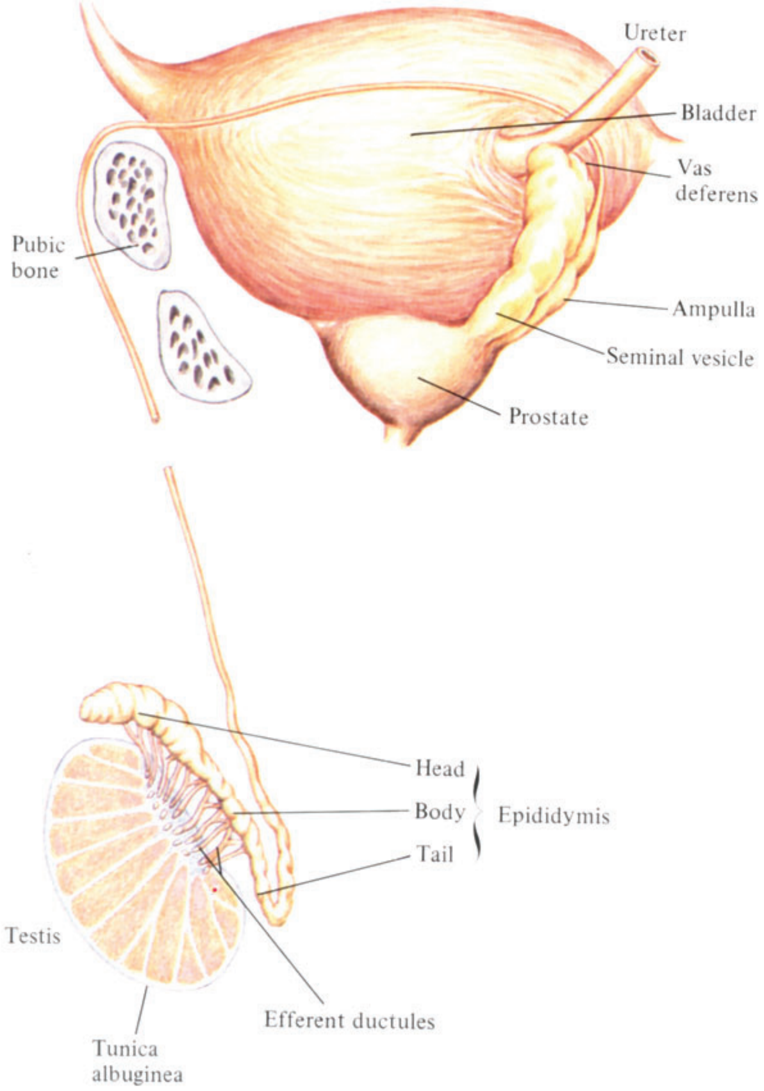


FIG. 3. Male reproductive system (lateral view).

The function of the testis is to produce sperm from the seminiferous tubules and to secrete androgen from the interstitial or Leydig cells.

The epididymis is a long narrow body surmounting the posterior border of the testis. It is divided into three parts: head, body, and tail. The head of the epididymis is enlarged and attached on the upper pole of the testis. The body is separated from the testis, and the tail is attached to the testis again at its lower end.

The head is composed of efferent ductules, which emerge from the testis. The ductules converge into a convoluted single duct system in the epididymal body, which connects with the vas deferens at the tail. The function of the epididymis is to collect sperm from the testis and allow them to mature.

The spermatic cord is a long, rounded bundle that originates at the internal inguinal ring and terminates at the upper pole of the testis. It consists of the vas deferens, blood vessels, lymphatics, and nerve fibers to the cord and testis. All these structures are loosely united by connective tissue elements and ensheathed by the same fascial coverings of the testis.

Vascular Supply

The blood supply of the scrotal wall is mainly derived from the external and internal pudendal arteries. The veins follow the arteries. The lymphatics of the scrotal wall form an exceedingly rich network and drain into the inguinal and femoral nodes.

There are two arteries in the spermatic cord: the internal spermatic artery and the artery of the vas deferens. The latter artery is derived from the superior or inferior vesical artery, runs along the vas and supplies it before branching to the epididymis and testis.

The internal spermatic artery, the main supplying artery of the testis, arises from the abdominal aorta just below the renal arteries, distributes a branch to the ureter, and joins the spermatic cord at the internal inguinal ring. It enters the testis at the mediastinum testis, distributing a branch to the head of the epididymis.

These two arteries are anastomosed together at their distal ends; hence, damage to any one will not compromise the testis at the distal end. One must be careful in working at the head of the epididymis because the testicular artery can be damaged, resulting in loss of function. In addition to these, a cremasteric artery, which is derived from the inferior epigastric artery, supplies coverings of the cord.

The veins of the testis and epididymis form the pampiniform plexus in the spermatic cord. This plexus is grossly divided into anterior and posterior groups; the former surrounds the spermatic artery, and the latter surrounds the vas deferens.

As the veins ascend, they decrease in number but increase in size and finally converge into the spermatic vein at the internal inguinal ring.

The right vein drains directly into the inferior vena cava at an oblique angle near the renal pedicle.

The left vein is valvular and drains into the left renal vein almost at a right angle. This fact may explain the increased incidence of varicoceles on the left side, as compared with the right.

The lymphatics of the scrotal contents follow the spermatic vessels throughout their course and drain into the lumbar nodes near the aorta and inferior vena cava. There is no direct connection with the inguinal nodes, an important factor in the treatment of malignant tumors of the testis (Fig. 4).

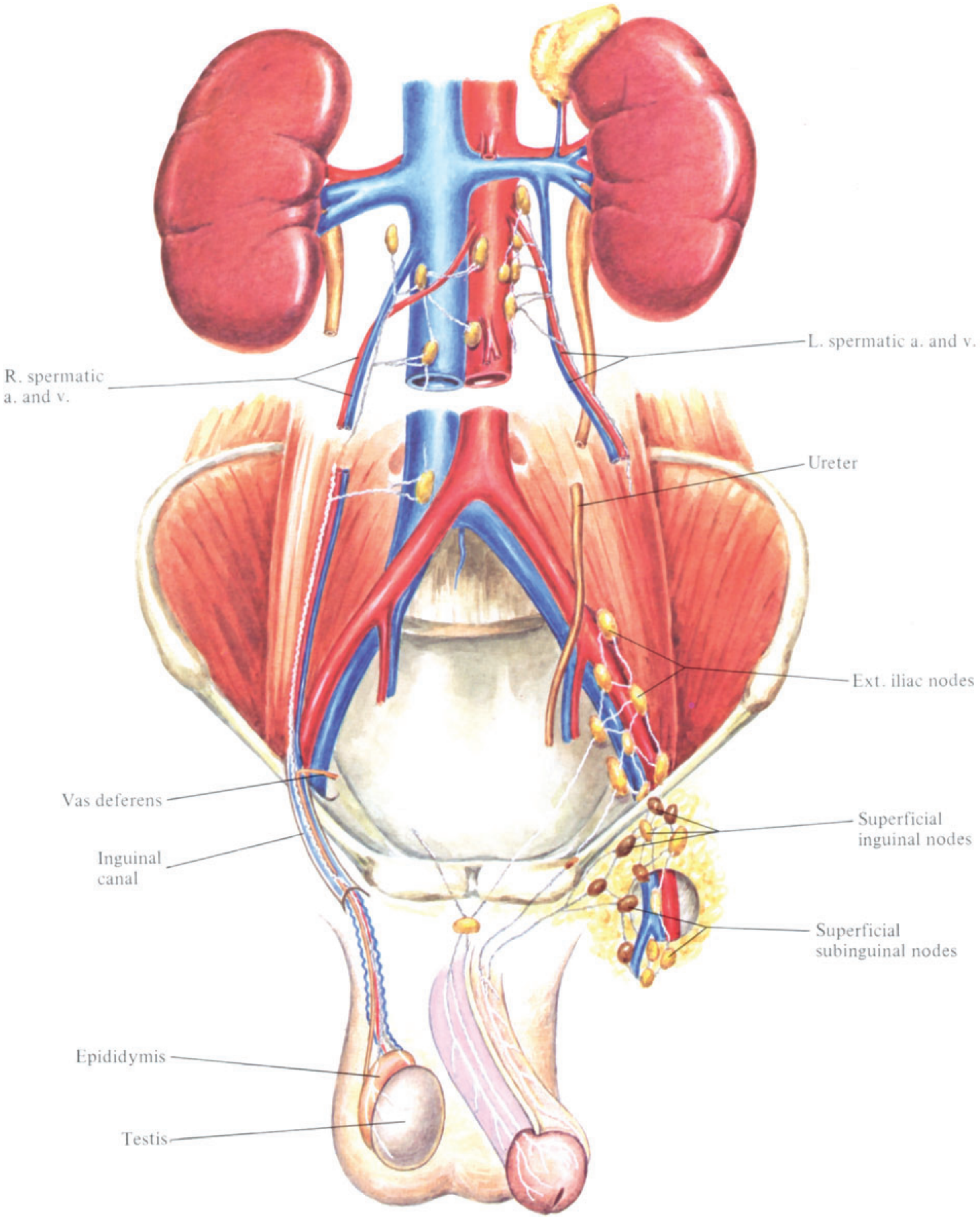


FIG. 4. Lymphatic drainage of penis and testis.

Nerve Supply

Sympathetic fibers to the testis and epididymis are derived from the renal and aortic plexus, accompanied by the spermatic artery and vas deferens. The pudendal nerve sends some branches of motor and sensory fibers to the skin and muscles of the scrotum (Fig. 5).

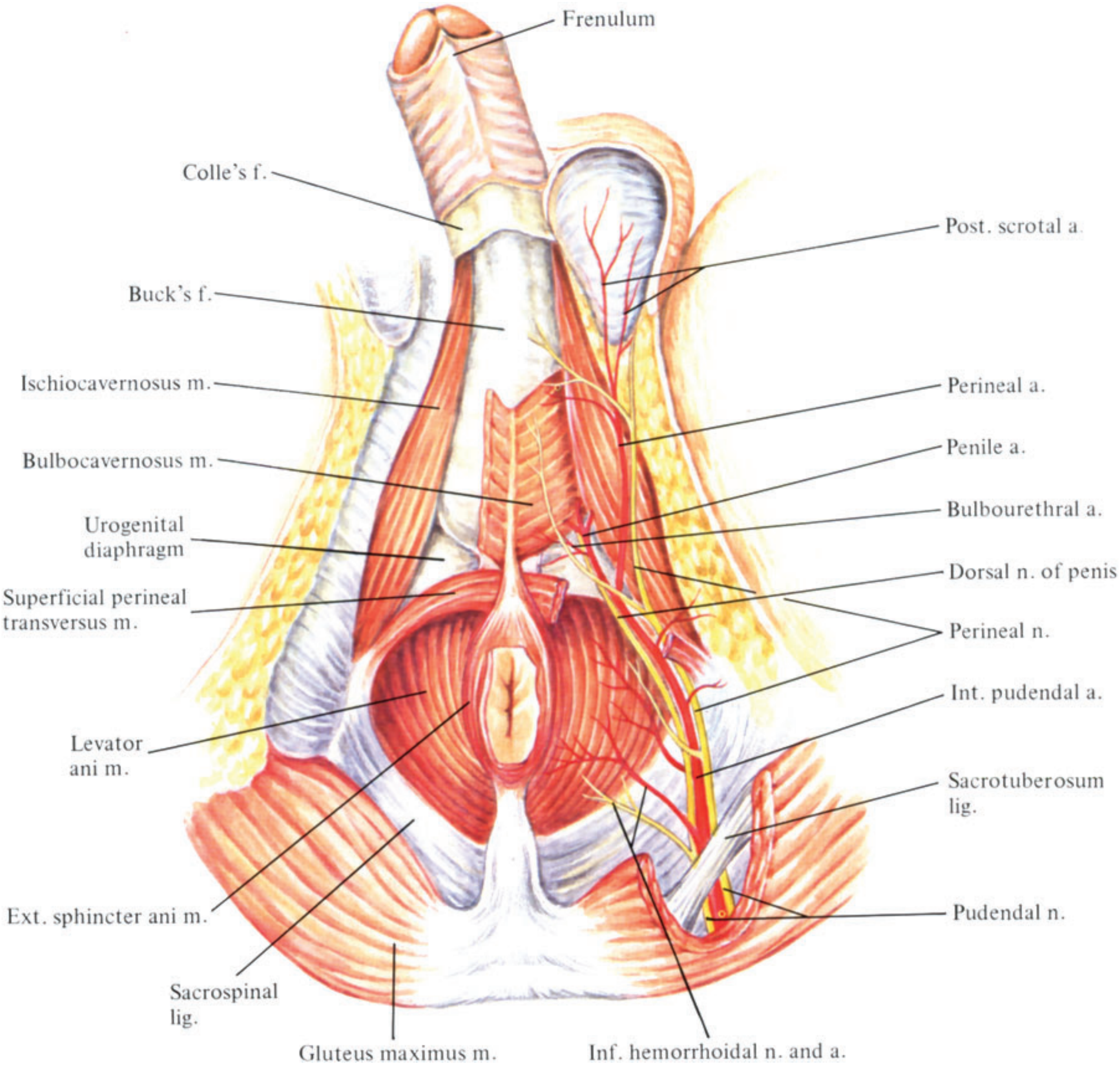


FIG. 5. Superficial structures of the male perineum.

Surgical Anatomy of the Seminal Vesicle and Vas Deferens

The seminal vesicles are paired lobulated sacs lying at the base of the bladder, superior to the prostate and anterior to the rectal wall and fascia. Each vesicle is a tubular structure with a blind end that constitutes a diverticulum of the lower end of the vas deferens. The seminal vesicle has a histologic structure similar to that of ampullated end of the vas deferens, a secreting type of epithelium. In the adult, it is about 4–5 cm long, but the length of the tube will reach 10–15 cm when uncoiled (Fig. 6). The open end of the seminal vesicle joins the vas deferens at the base of the prostate to form the ejaculatory duct. The latter pierces the prostate between the posterior and median lobes, and enters the prostatic urethra through the seminal colliculus (verumontanum).

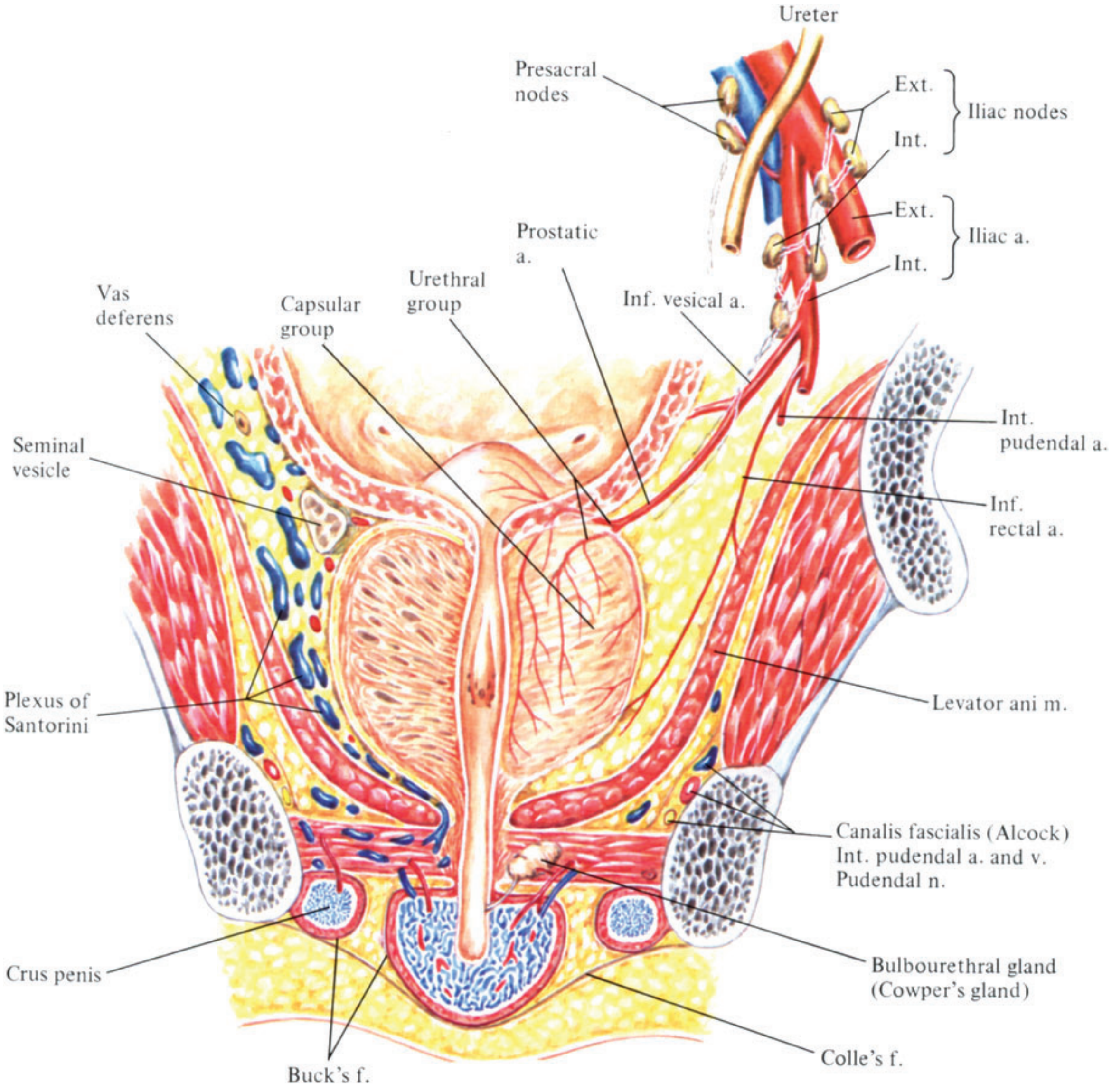


FIG. 6. Prostate, seminal vesicles, and vas deferens (posterior view).

The vas deferens passes along the base of the bladder, along the medial aspect of the seminal vesicles, and across the terminal part of the ureter; it is covered by peritoneum, hooks around the origin of the inferior epigastric artery, joins with other constituents of the spermatic cord in the inguinal canal, and connects the lower end of the epididymis at the dependent scrotal end (Fig. 3).

The blood supply to each seminal vesicle is derived from the inferior vesical and the middle hemorrhoidal arteries. Veins drain into the vesicoprostatic plexuses. The artery is closely attached to the vas wall. The artery runs from the base of the bladder to the epididymis and anastomoses with the testicular artery.

Operative Techniques

90. Left Hydrocelectomy in the Infant

A hydrocele is a collection of fluid within the tunica vaginalis, and usually surrounds a testis. It can extend superiorly up the cord.

90-1. A scrotal incision is made and carried through the dartos, and external spermatic and internal spermatic fascia. *The hydrocele sac including testicle is delivered outside the skin margin.* We usually explore the anteromesial cord proximal to the hydrocele, to rule out the presence of an indirect hernia. If a hernial sac is also present, then the incision is extended up into the inguinal area, and a herniorrhaphy is completed.

The line of incision through the hydrocele sac is indicated by the dotted line.

90-2. *Excessive sac is excised.* The edges and remaining sac are reversed so that the newly cut edges of sac are reapproximated around the lower cord and epididymis with 3-0 or 4-0 chromic catgut.

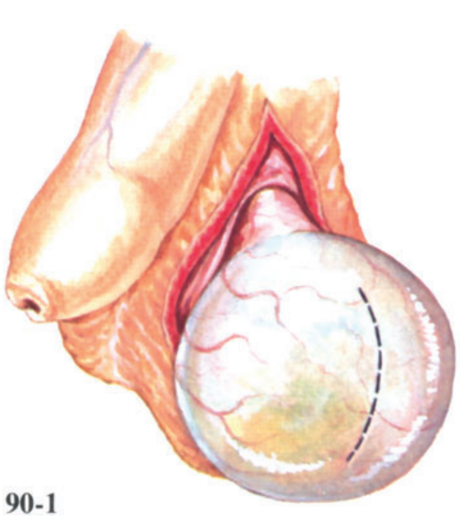
91. Hydrocelectomy in the Adult

91-1. *The hyrocele is delivered outside the scrotal incision.* The sac is opened and the borders are retracted with clamps. Excessive sac is excised (dotted line).

91-2. *The edges of the tunica vaginalis are reversed around the cord* so that the inner surfaces are now exteriorized. The edges are sutured with 3-0 chromic catgut.

91-3. When the tunica vaginalis is thickened and indurated, it may not easily be closed around the lower cord. In this instance continuous right and left sutures (3-0 chromic catgut) are placed around the edges of the sac to ensure hemostasis.

91-4. *Closure is by layers.* The internal and external spermatic fascia can be closed as a single layer (3-0 chromic catgut). The dartos and skin are reapproximated with interrupted 3-0 chromic catgut. A drain from the wound may be placed in the inferior margin of the skin in selected instances. It is secured separately with a safety pin, and is removed in 24 hours if drainage is minimal.



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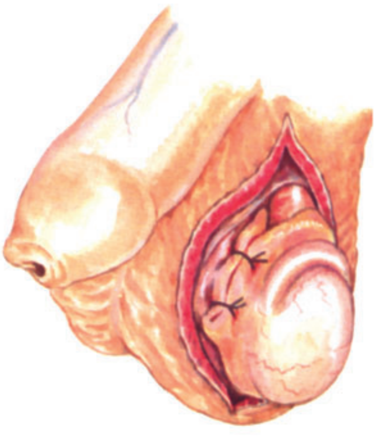

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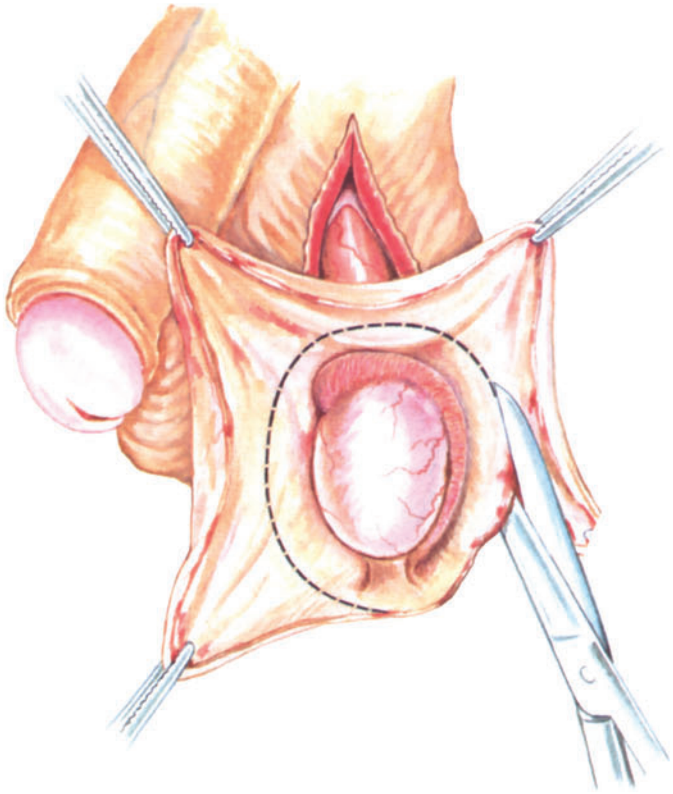

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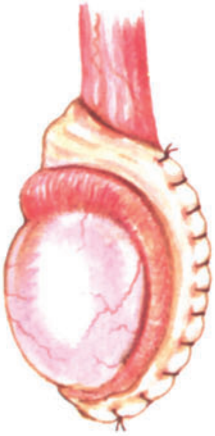

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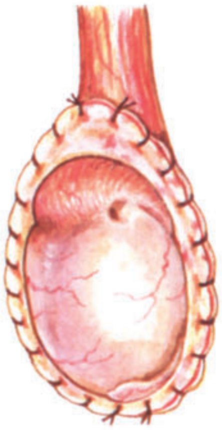

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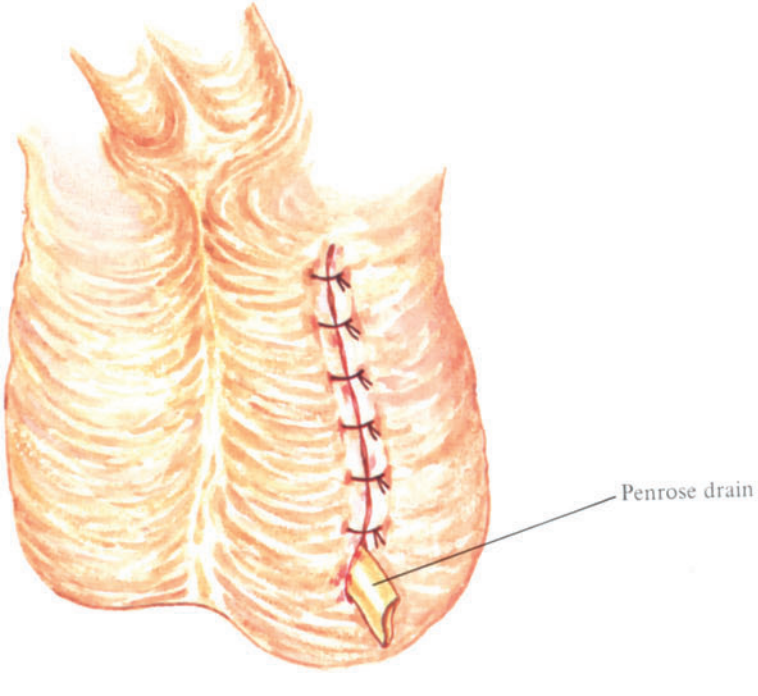


91-4

92. Spermatocelectomy in the Adult

A spermatocele is a retention cyst of small tubules within the head of the epididymis. The differential diagnosis of a small 2–3 cm mass in the scrotum is often difficult. A hydrocele, if large, covers the entire gonad. It will transilluminate artificial light. A spermatocele is located near the head of the epididymis (superior location) and will not transilluminate light.

92-1. The testis, cord, and epididymis are exposed. *The spermatocele is grasped with forceps and carefully excised.* Note its location in relation to the head of the epididymis.

92-2. *The spermatocele sac is circumscribed at its base,* and its attachments to the head of the epididymis are exposed. A ligature is placed around the tubular attachments to the head of the epididymis.

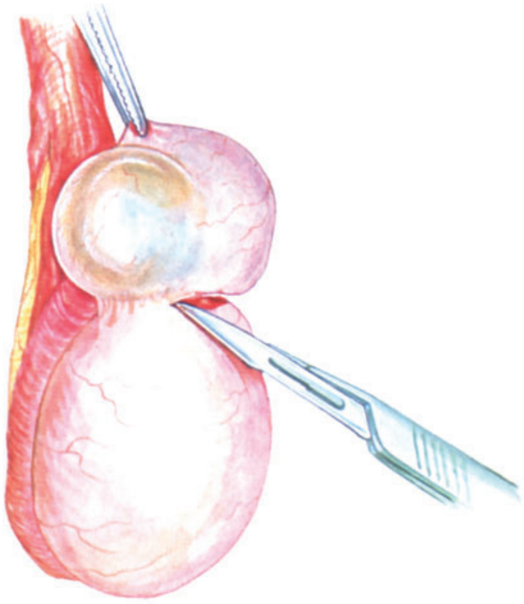
92-3. *The spermatocele is excised.* Closure is in the usual fashion (see Fig. 91-4). A Penrose drain is not necessary.

93. Left Varicocelectomy

A left varicocele is a condition characterized by dilation and tortuosity of the deep veins of the pampiniform plexus. A symptomatic varicocele may be treated surgically if the male patient is proved to be infertile. In our experience, three semen analyses will show a low motility score and 20%–25% immature and tapered sperm forms on morphologic examination.

93-1. We use a high left-sided slightly oblique line of incision.

93-2. *The approach to the left spermatic vein is extraperitoneal.* The muscles are separated between muscle fibers. In an obese patient only the external oblique muscle is incised along the horizontal plane. Added exposure can also be gained by incising the lateral left border of rectus sheath.



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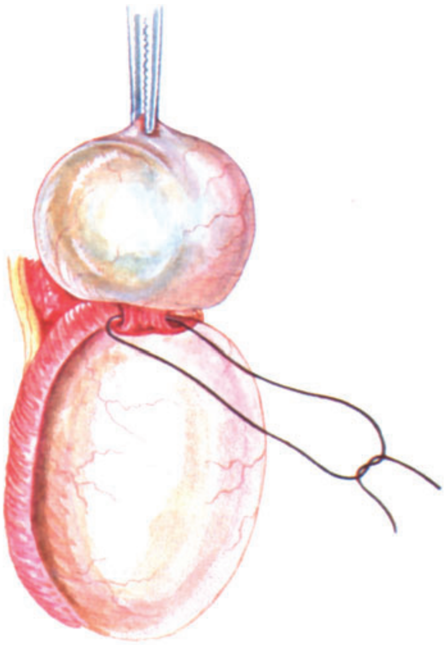

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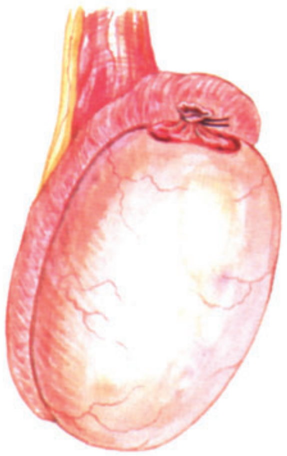

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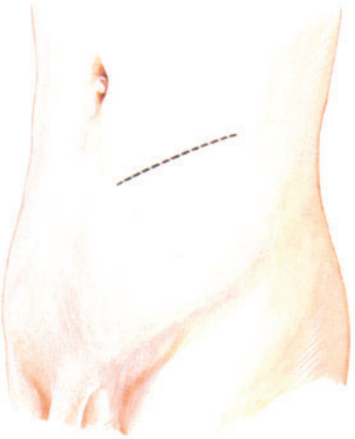

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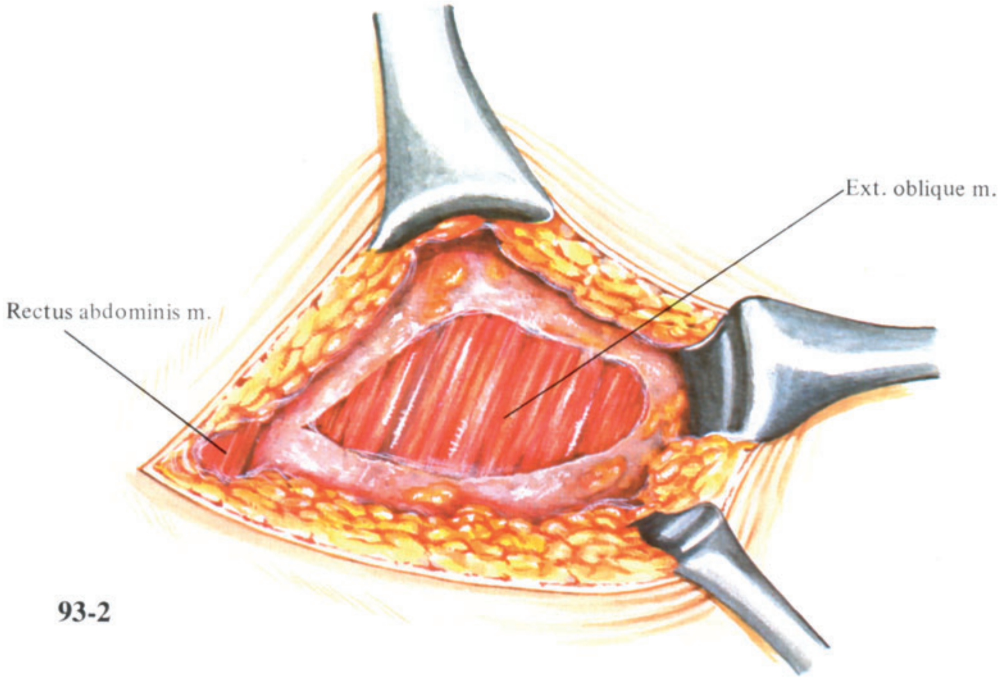

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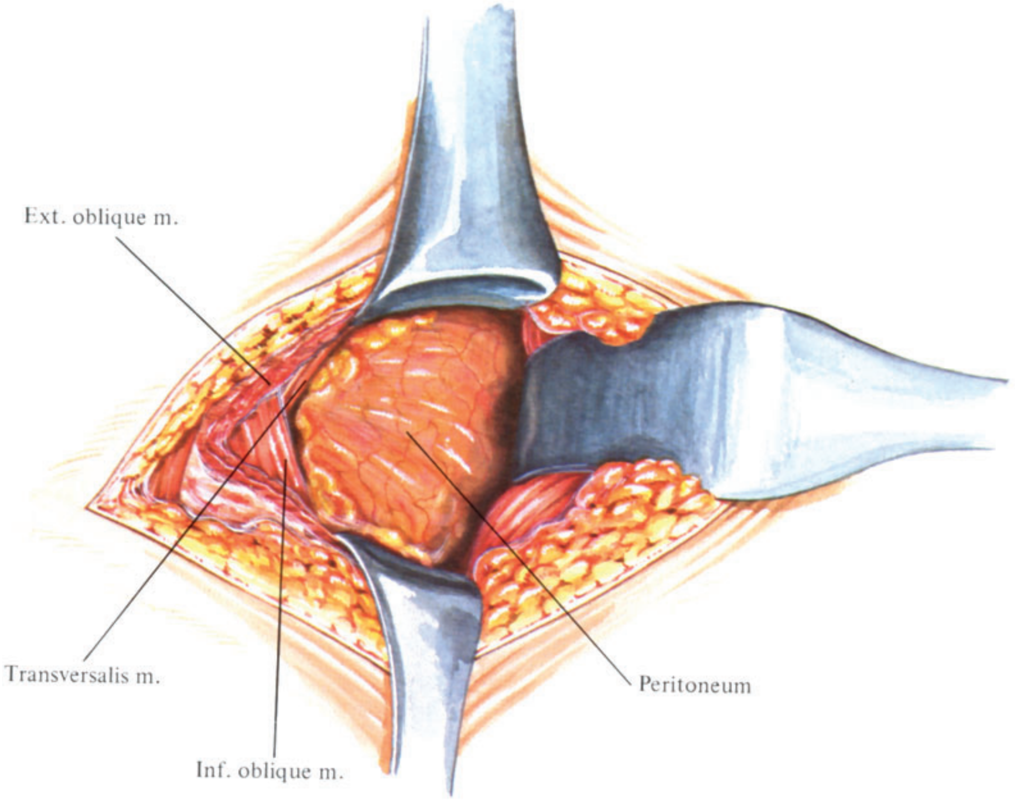


93-3

93-3. *The deeper muscles are separated.* The edge of the rectus abdominis muscle can be seen on the medial aspect. The illustration includes the internal oblique and transversus abdominis muscles. By using narrow Deaver retractors medially, one can easily reach the floor of the cavity.

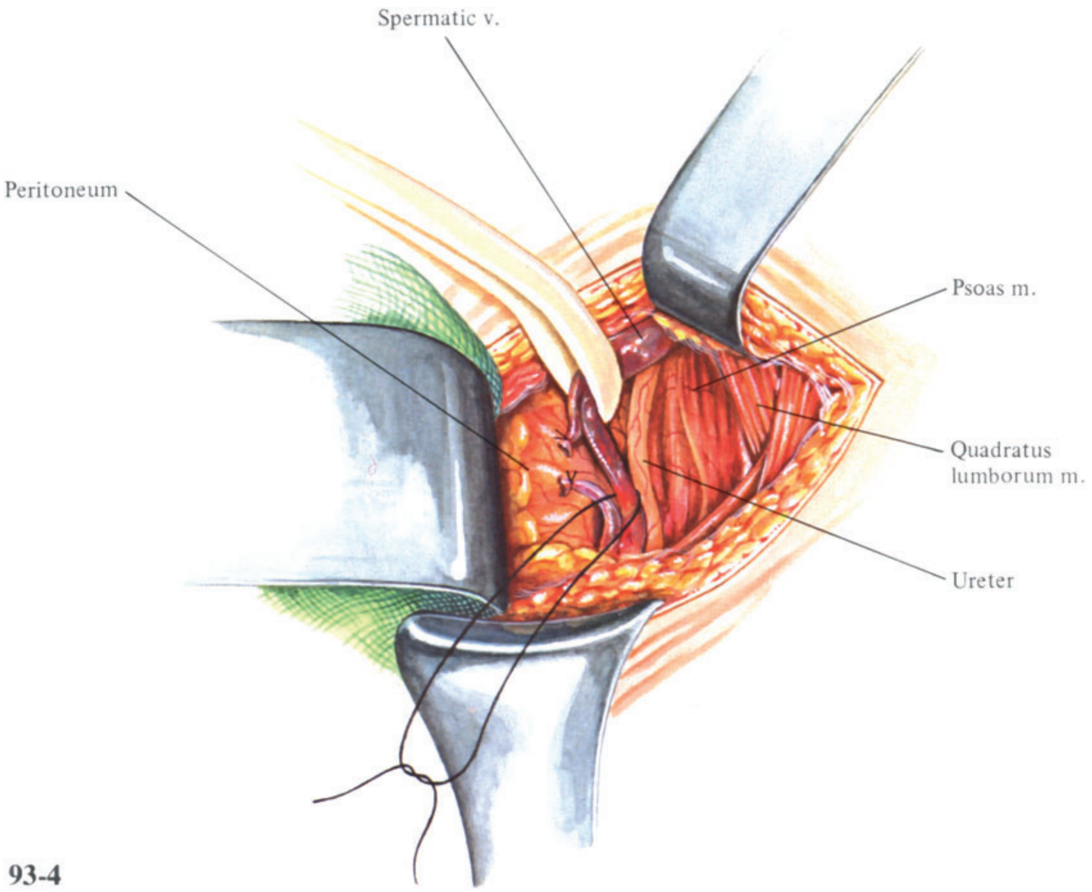
The psoas major muscle is exposed by wiping the peritoneal lining and its contents medially. Usually a sponge on a ring forceps is useful in gaining appropriate exposure.

93-4. By exposing the psoas major muscle medially, one comes upon the transversalis fascia, which serves as an envelope around the spermatic vein. Careful dissection through this envelope will reveal at least one and, in most instances, two or more spermatic veins. Our rule is that if we find an exceedingly large pencil-sized spermatic vein, then we may find only one or two other veins coursing superiorly away from the varicocele. At times we have found three and even four veins in this region. After the *veins* are exposed they *are doubly ligated and transected in between*. The ureter is not exposed by carefully following this approach. In the illustration we have shown the ureter for orientation. If one wishes to locate the ureter, then one simply needs to take the narrow Deaver retractor and move more medially and posteriorly where the ureter can be easily seen running superiorly and inferiorly. The ureter is often slightly adherent to the posterior parietal peritoneum.

This incision can be used to approach the left midureter for removal of a calculus.

94. Orchiopexy for Undescended Testis (Ombredanne Procedure[1])

We believe that the procedure for cryptorchidism should be performed prior to age 5 years. If delayed into puberty, we believe the patient's fertility potential will be reduced.

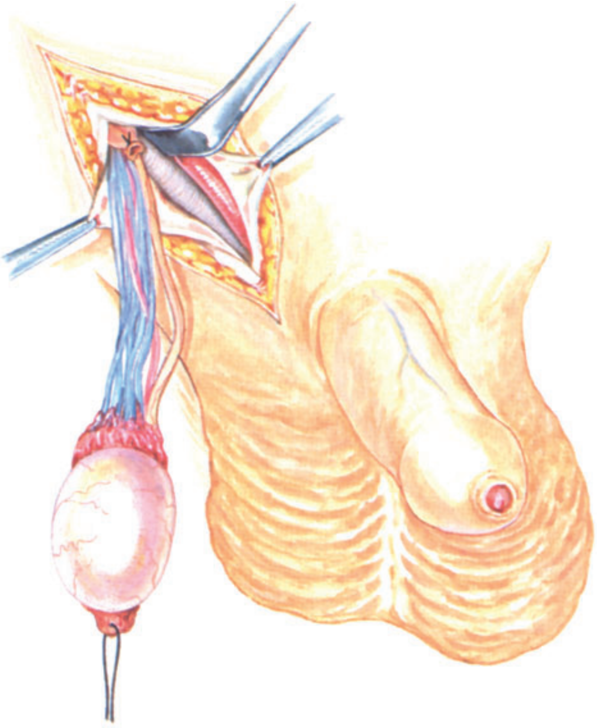


93-4

94-1. *An inguinal incision is made on the right.* The testis is found in the inguinal canal. A stay suture is placed through the gubernaculum, and the testis, including cord, is brought down to the outer border of lowermost scrotum.

94-2. *A tunnel is made by the index finger.* The scrotal septum is tented to the opposite scrotal margin. The skin, fascia, and interscrotal septum are incised.

94-3. A curved clamp is tented against the tip of the index finger and brought upward to the lower inguinal skin incision. The gubernaculum is grasped and *the right testicle is brought out the left scrotal skin margin without tension.* The interscrotal septum is closed with 3-0 chromic catgut to prevent the testis from retracting to the right lower inguinal area.



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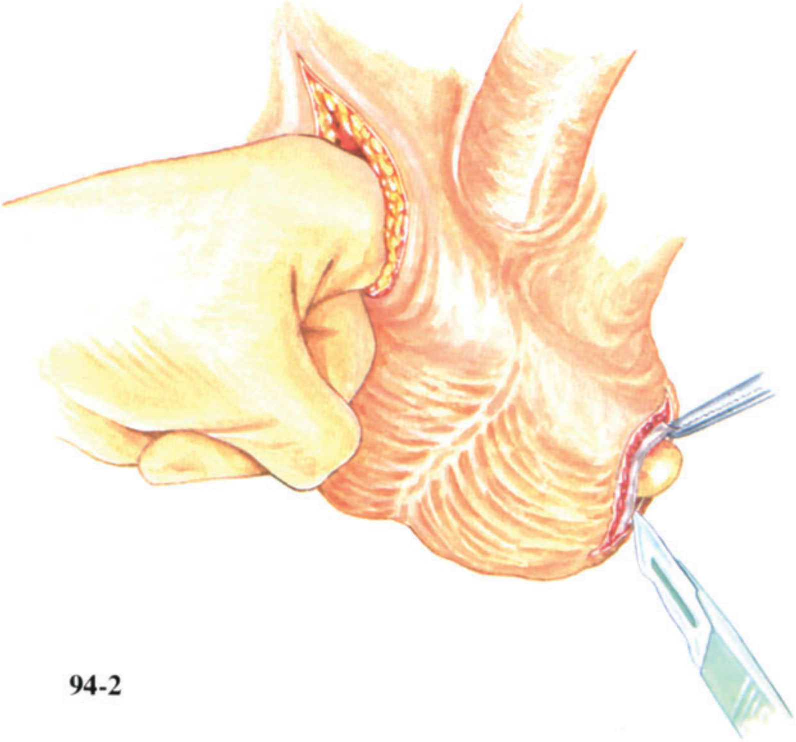

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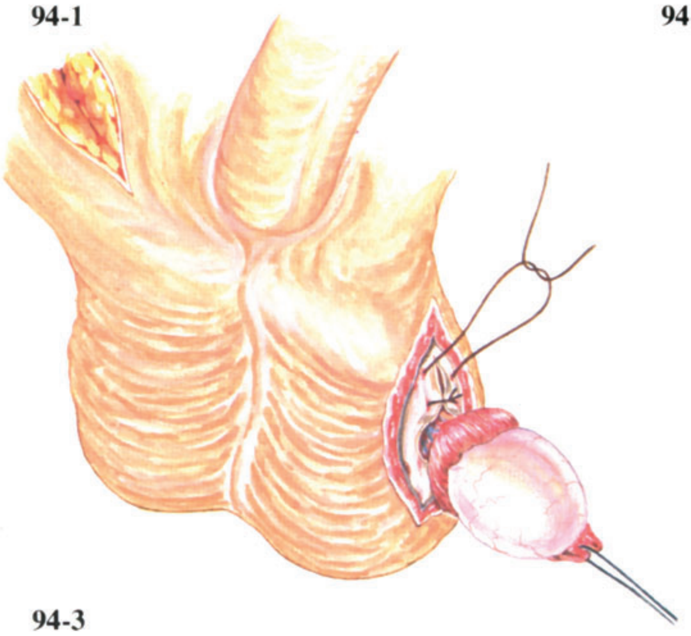

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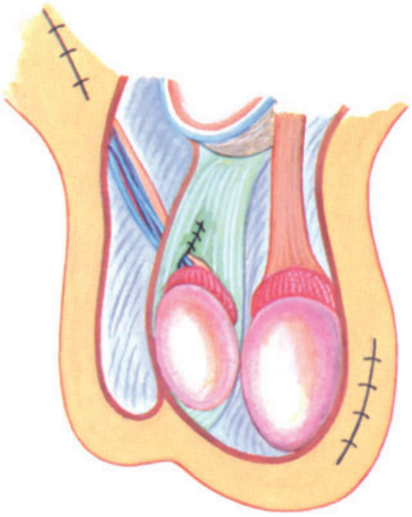

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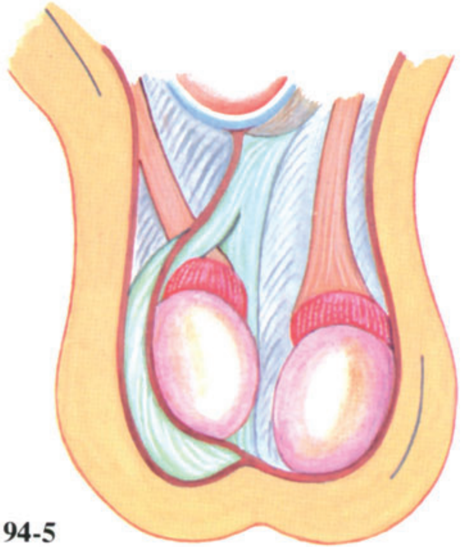


94-5

94-4. *The final resting place of the right testicle* is demonstrated schematically. The septum is indicated in brown, and the skin incisions can be seen.

94-5. After a few months, the gross appearance on examination of the scrotum is remarkable. *Each testis is located in a lateral aspect of the scrotum.* The schematic shows the true fascial relationships.

95. Subcapsular Castration

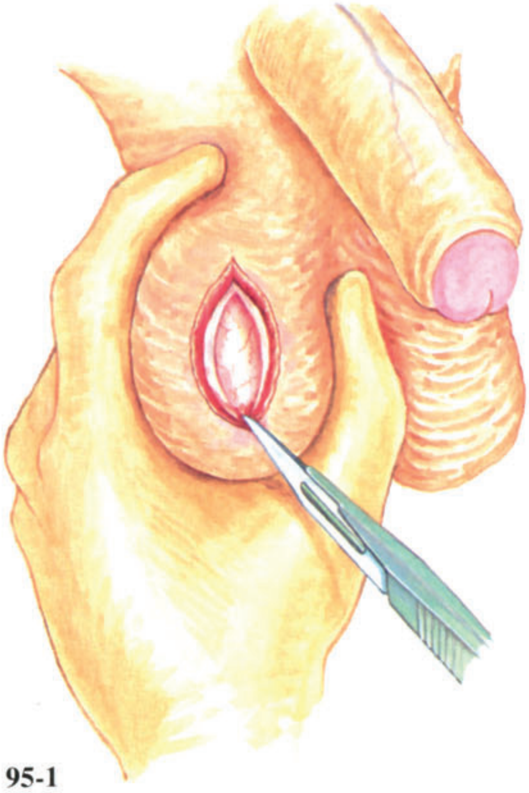
An alternative to a complete orchiectomy on each side is the technique for subcapsular castration. These procedures would be used as palliative treatment for stage D adenocarcinoma of the prostate. Estrogen therapy is also continued in this selected group of patients.

95-1. The appropriate testis is grasped firmly and immobilized. *A vertical incision is carried down to the tunica albuginea.*

95-2. *The testis is delivered outside the scrotal incision.* The tunica albuginea is incised, and both margins are grasped. The seminiferous tubules are removed meticulously.

95-3. *The tubules located at the head of the epididymis are grasped with clamps.* A ligature is placed at the neck and secured.

95-4. *The margins of the tunica albuginea are reapproximated.* Closure of the scrotum and underlying fascia is by layers (Fig. 91-4). A drain is not needed.



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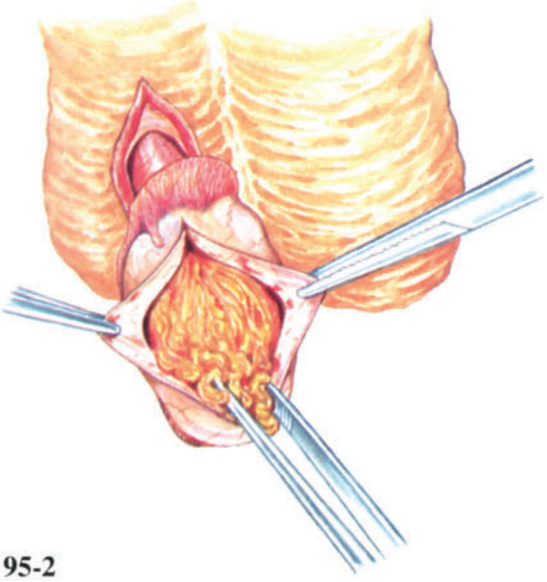

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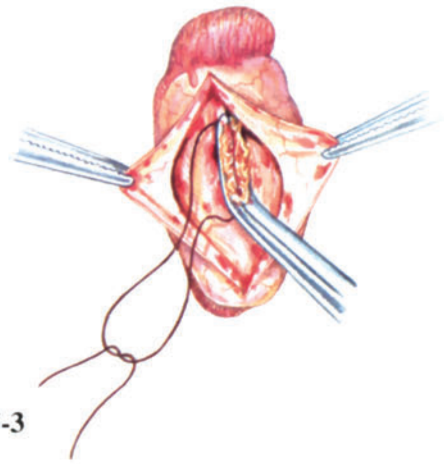

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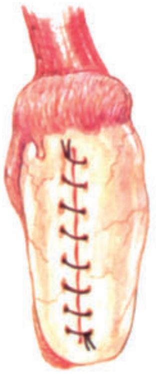
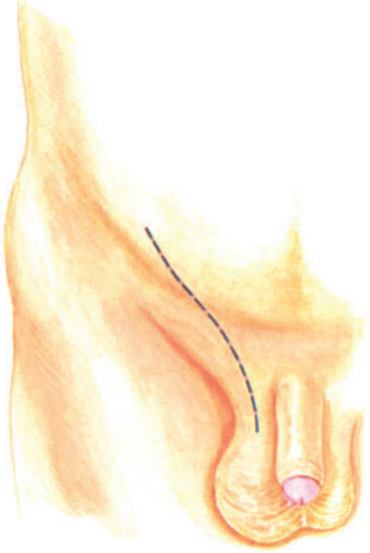


95-4

96. Right Radical Orchiectomy

Enlargement and induration of a testis may be secondary to neoplasia. A variety of germinal cell tumors can occur in the male between 18 and 35 years of age. There is no history of trauma in the case of neoplasia although an injury may bring the involved testis to the physician's attention.

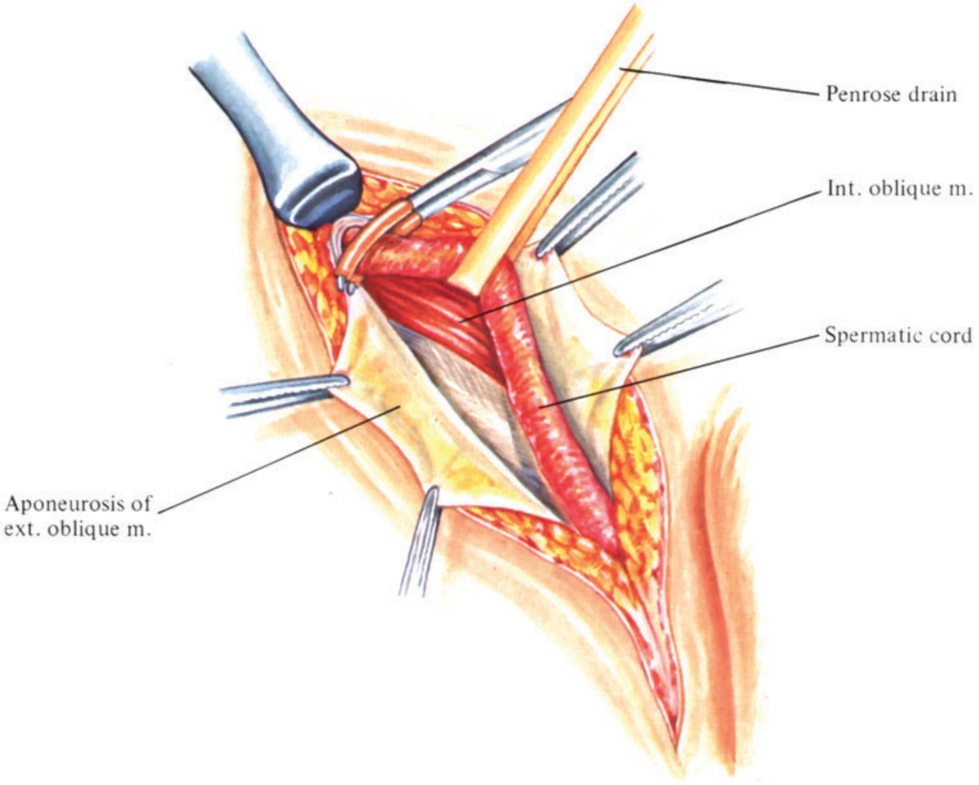
In nonseminomatous germinal tumors, biochemical markers in the blood may serve as useful prognostic indicators; these are considered in the discussion of bilateral retroperitoneal lymph node dissection (p. 227).



96-1

96-1. *The inguinal incision extends from internal ring down to the superior portion of the right scrotum* (dotted line).

96-2. The external oblique aponeurosis is incised and retracted. The entire spermatic cord is dissected free, starting near the external inguinal ring. A Penrose drain is used to isolate the cord, exposing the internal oblique muscle. The proximal cord is clamped with a rubber-shod clamp prior to delivering the testis into the wound. The scrotal incision can be extended inferiorly if the testicular mass is moderately enlarged.



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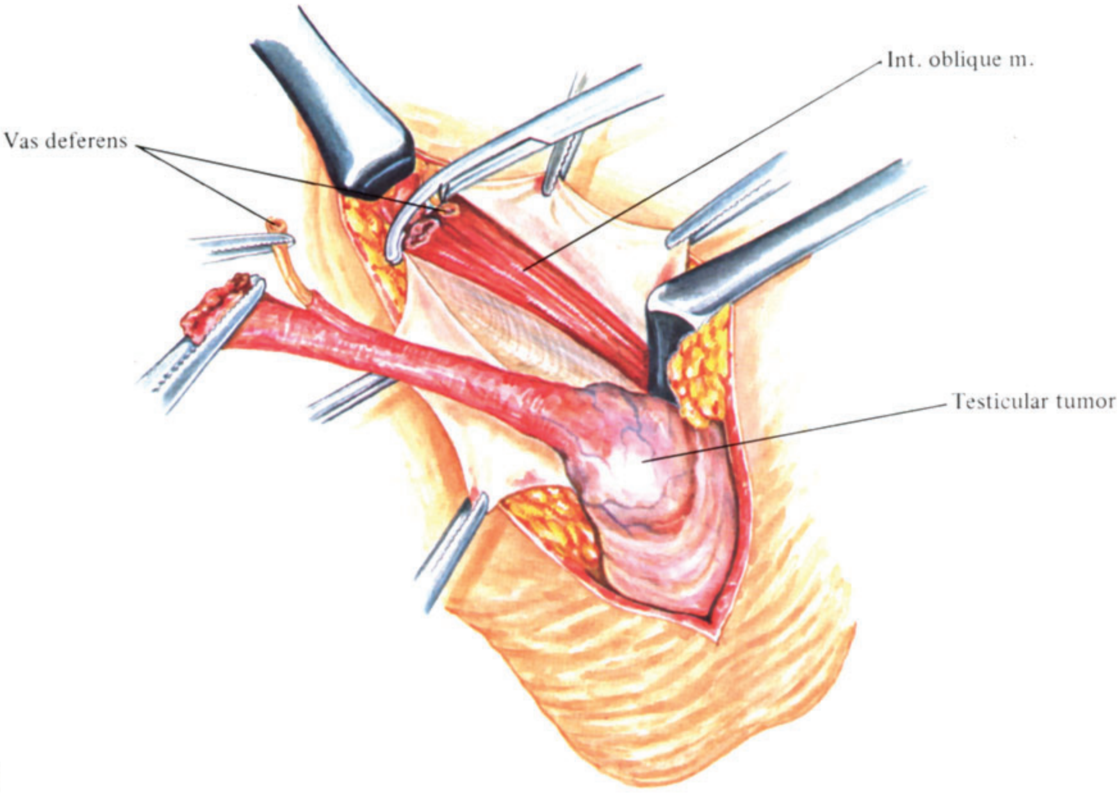

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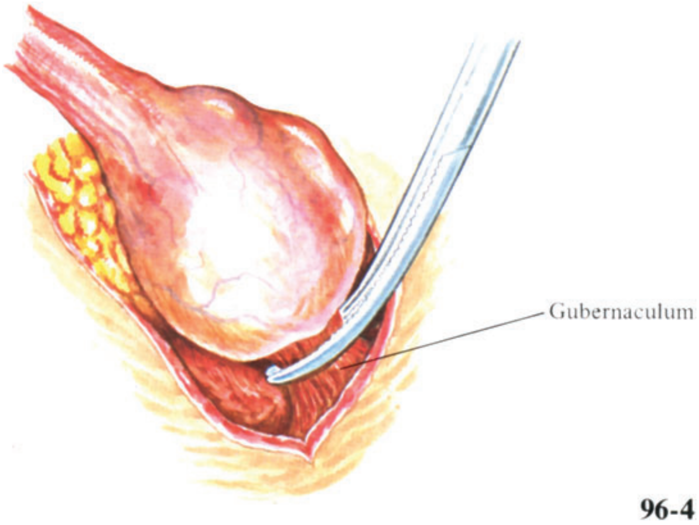


96-4

96-3. *The spermatic cord is doubly clamped.* Care is taken to separate the vas deferens from the vascular and lymphatic structures. Separate clamps are used during transection of the cord. Separate ligatures (2-0 silk) are placed around the proximal cord and vas deferens.

96-4. *The gubernaculum is freed and clamped.* The testis and attached spermatic cord are removed.

97. Bilateral Retroperitoneal Lymph Node Dissection

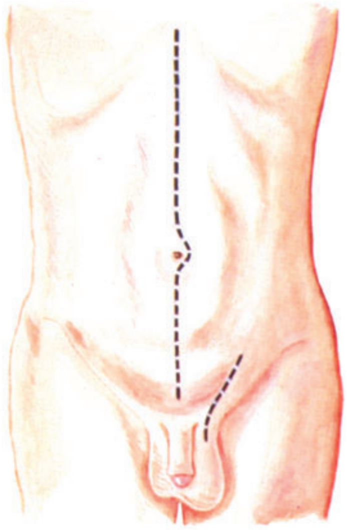
Before lymph node dissection is undertaken, it is worth determining if tumor has extended beyond the inguinal canal. Certain diagnostic studies are indicated.

Pedal lymphangiography has been recommended in many instances. It is often useful in demarcating areas of lymph node metastasis (80%). However, we agree with Skinner,[2] who has stated that the contrast medium employed interferes with the ease of surgical dissection. We no longer obtain lymphangiography routinely.

A chest study with tomography is useful to rule out the presence of tumor metastasis.

An intravenous urogram is obtained if a recent study has not already been performed. We now believe that the computerized tomographic scan (with contrast media in the kidney), focusing on the retroperitoneal node sites between aortic bifurcation and renal pedicles, is the most definitive study for evaluating the presence of positive lymph nodes. We have been impressed by its usefulness, particularly around the great vessels at the renal pedicle.

In nonseminomatous germinal tumors the biochemical markers in the bloodstream are also useful. Elevated titers of human chorionic gonadotropin (beta subunit) and/or alpha fetoprotein are indicative of lymph node metastasis.

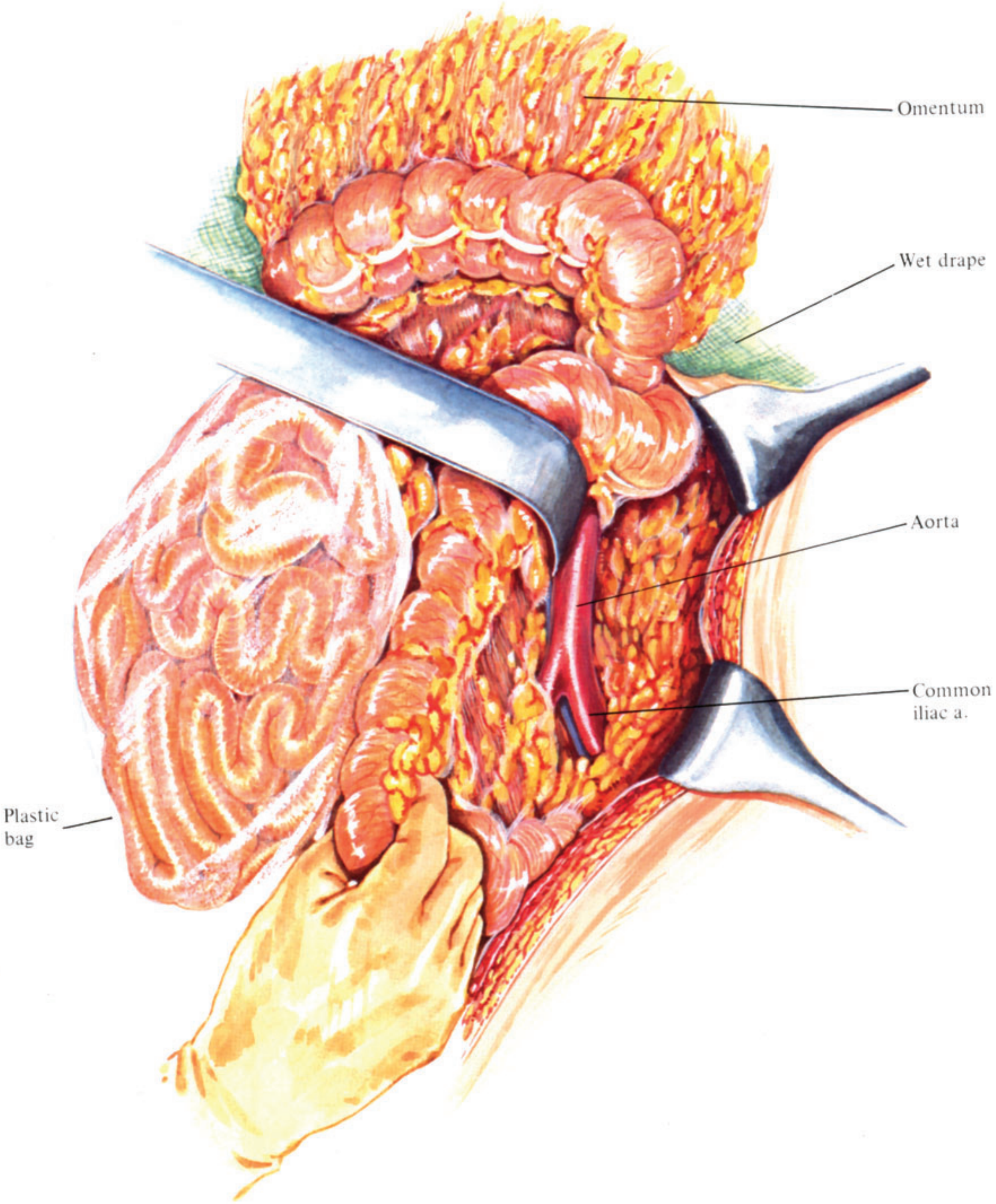


97-1

97-1. *A midline incision is employed, extending from the xiphoid to the symphysis pubis.* The abdomen is explored. If nodes are enlarged above the renal pedicle, then the case is inoperable, and a biopsy only is taken. Tumor sites are marked with silver clips.

97-2. *The retroperitoneal space is fully explored* by mobilizing the entire left colon and retracting it to the right. The transverse colon is protected and placed on the superior abdominal wall over a moist drape. The small intestines are placed in a plastic bag, and the noose is tightened at the root of the mesentery. The small bowel is placed on the right lateral abdominal wall.

The duodenum is mobilized medially and superiorly to expose the right renal pedicle.



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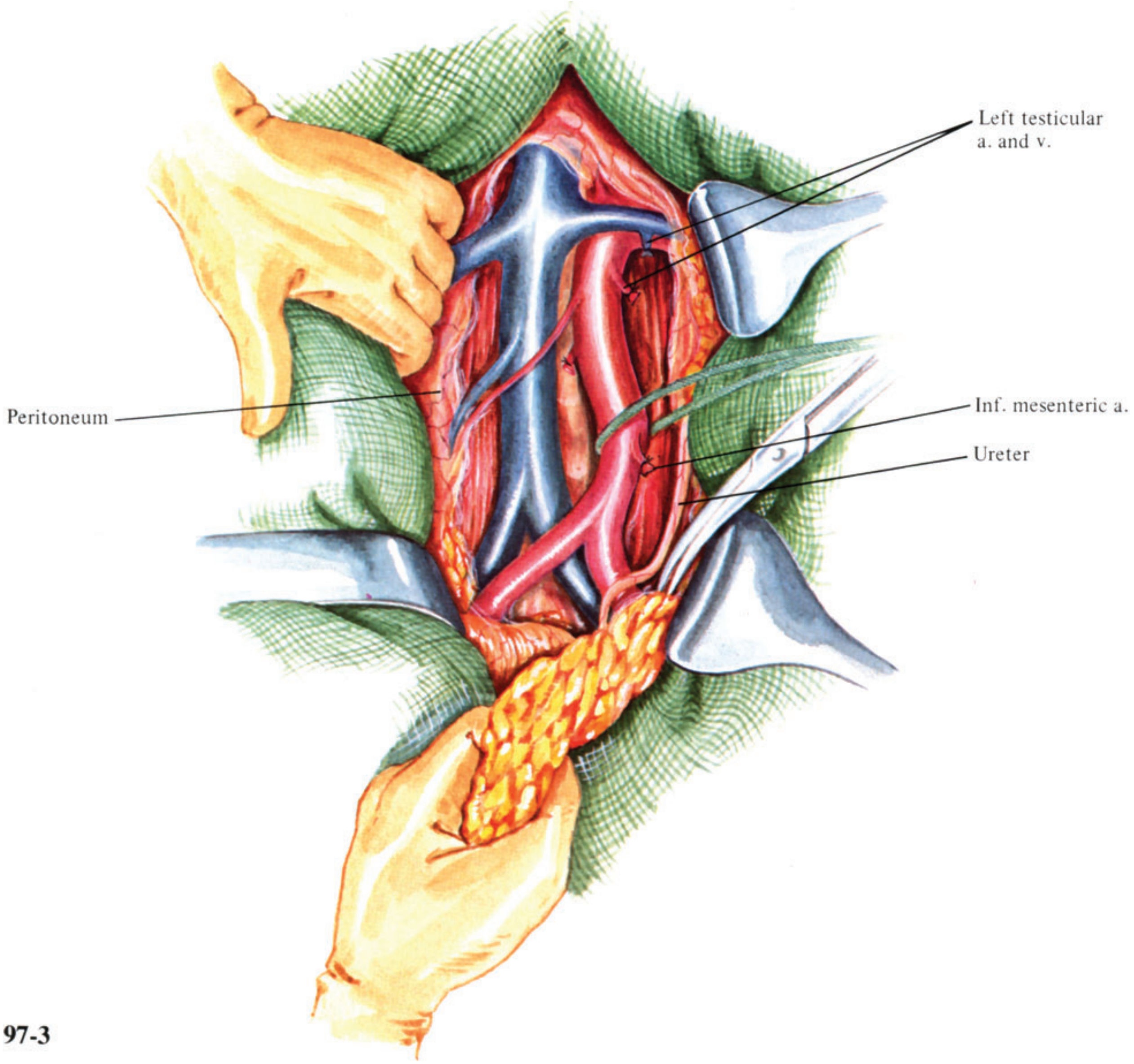
97-3. *Dissection of the ipsilateral renal pedicle (left) is begun.* All lymphatics and areolar tissue are removed circumferentially around the renal vein and artery, extending superiorly to the superior mesenteric artery. The spermatic artery near its origin and the vein are dissected on the left, doubly ligated, and transected in between. The dissection is carried anteriorly over the aorta and to the inferior vena cava. The dissection is now extended circumferentially, around the right renal vein and renal artery. Fatty tissue from the lateral portion of the vena cava is dissected free en bloc. Lumbar veins behind the vena cava and below the renal pedicle may be doubly ligated with small-size hemoclips. An umbilical tape, carefully placed superior to the right renal vein and behind the vena cava, assists in the dissection posterior to the vena cava. A second umbilical tape is now placed around the aorta above the crossing of the left renal vein. This maneuver assists in the dissection between the two great vessels and behind the aorta. All the lymphatic and areolar tissues are removed from around and between both great vessels. The lateral borders for the dissection are



97-3

the longitudinal course of each ureter. The dissection is carried down past the bifurcation of the aorta. We usually ligate and transect the inferior mesenteric artery to assist in the complete dissection.

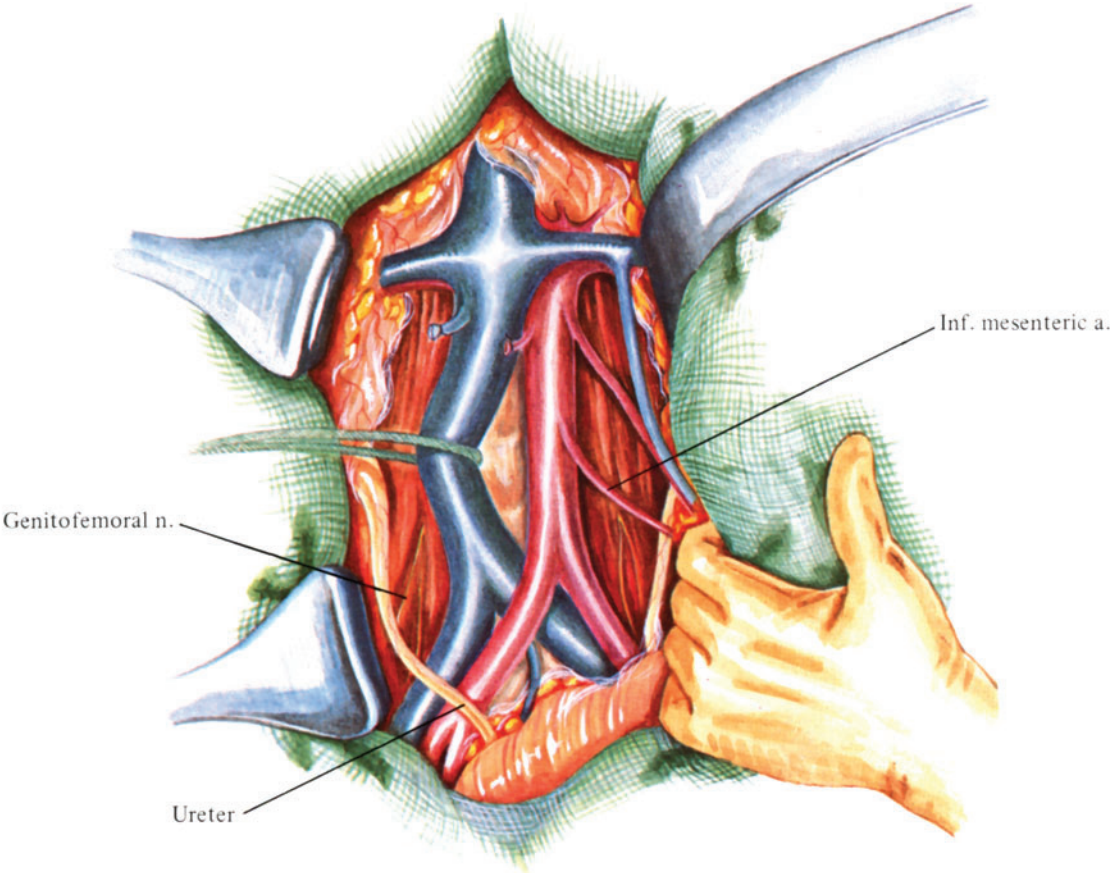
Dissection is usually continued distally to the bifurcation of the common iliac artery on the contralateral side. On the side of the tumor, the spermatic artery and vein, along with the cord (the vas deferens coursing from the prostate), are dissected and removed in toto to the internal inguinal abdominal ring.

After completion of the dissection, the aorta can be lifted from its posterior bed except for posterior attachments of the lumbar arteries, the major tributaries, superior mesenteric artery, and both renal arteries. The inferior vena cava can be similarly elevated. No areolar or lymphatic tissue is seen when the great vessels are moved in various directions.

After the dissection is completed, the mobilized duodenum and left descending colon are replaced in their original location and sutured to the parietal peritoneum. A routine appendectomy is not usually performed.

Closure is by layers. We use 0 nylon interrupted sutures on the fascia instead of wire. Penrose drains are not necessary.

97-4. *The lymph node dissection for a right-sided nonseminomatous germinal tumor is completed.* The vena cava is retracted laterally. Both renal pedicles can be seen. The right spermatic vein is ligated proximally. The ureters can be seen on each side. The inferior mesenteric artery has been preserved in this instance.



97-4

Epididymal and Spermatic Cord Surgery

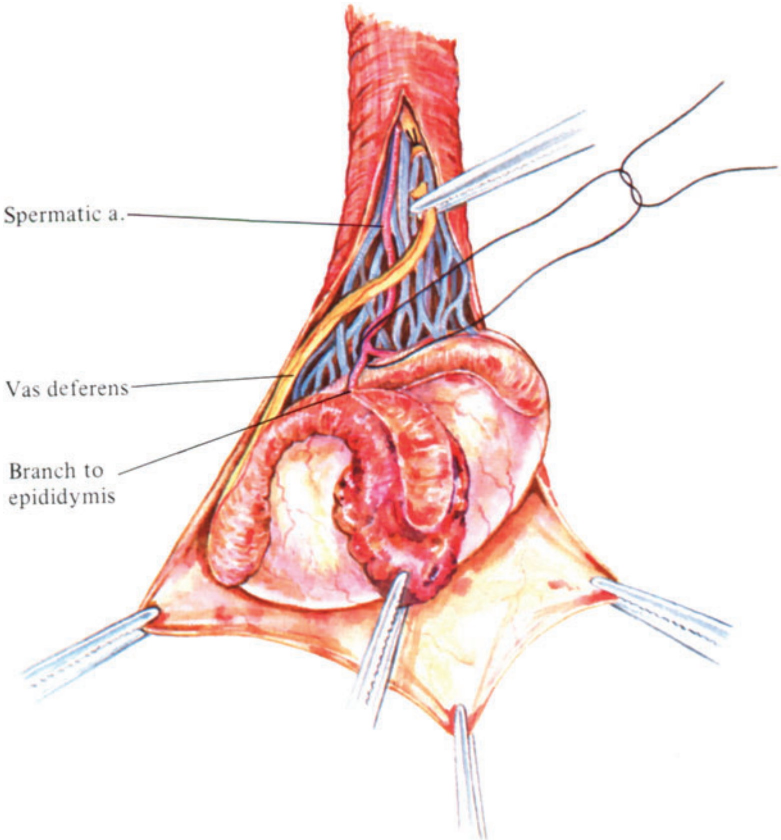
98. Epididymectomy

Inflammation of the epididymis secondary to bacterial infection may leave a slightly enlarged and tender epididymal body. If the patient is past the third decade of life and is symptomatic, an epididymectomy may be indicated.

98-1. *The testis surrounded by its fascial investments is delivered outside the scrotum.* The tunica vaginalis of the testis is opened. The edges are retracted. Care must be taken in dissecting the head and body of the epididymis from the testis. As the dissection proceeds, the testicular branch and epididymal branch of the internal spermatic artery can be isolated. The testicular branch must be preserved.

The vas deferens can be divided superiorly and ligated on both sides.

98-2. *The tunica vaginalis of the testis can then be loosely reapproximated* with interrupted 3-0 chromic catgut sutures.



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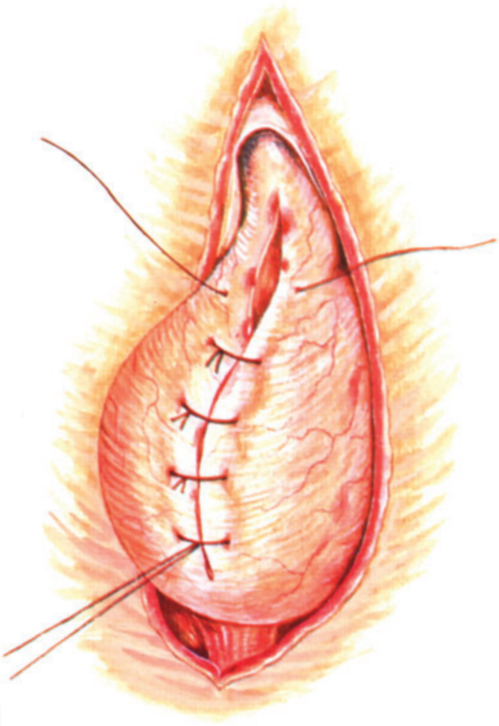

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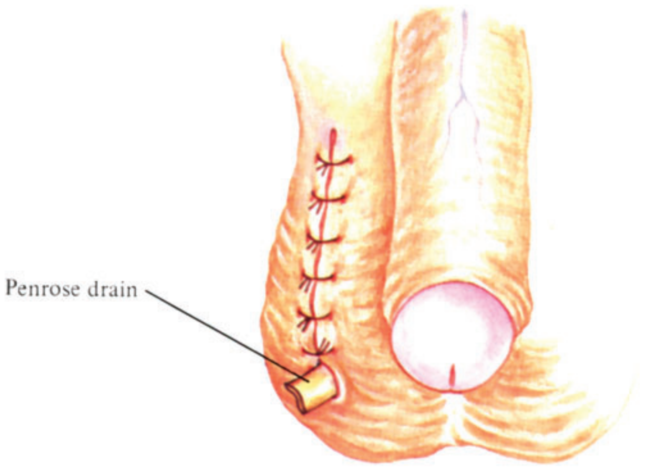


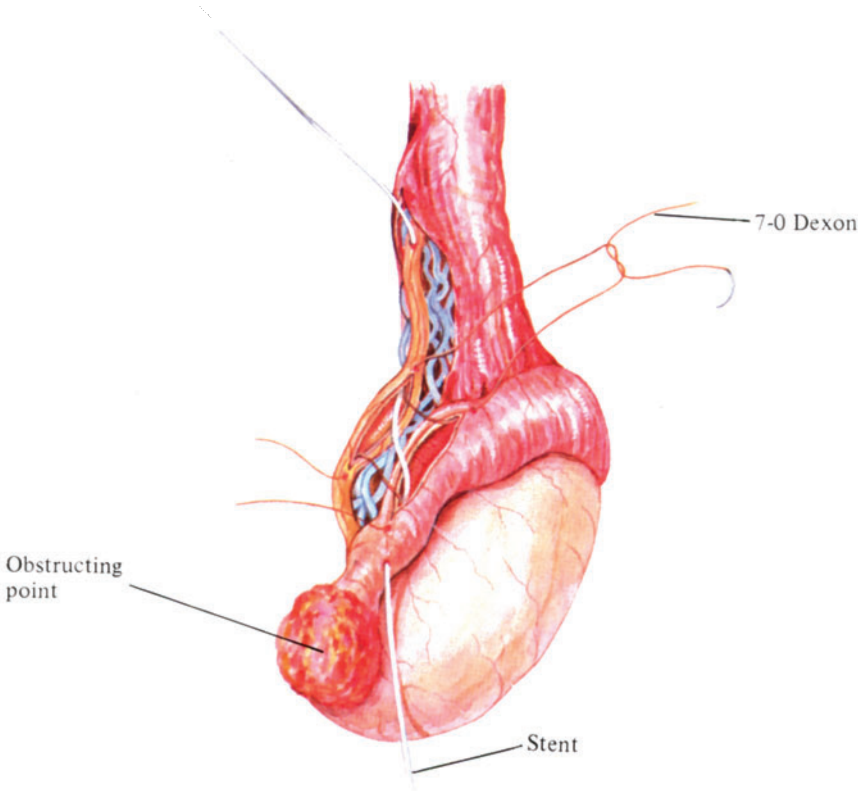
98-3

98-3. *Scrotal skin closure is completed.* A Penrose drain is optional, depending on the amount of inflammation and drainage encountered. The drain is removed in 24 hours.

99. Epididymovasostomy

The indication for this procedure is the finding of a selective block or fibrosis in the distal tail of the epididymis. Tests indicate that the patient is azoospermic, and a distal vasogram demonstrates the site of blockage.

99-1. The body of the epididymis near the tail is freed. The vas deferens near the tail is also freed. It is important that the tubular ramifications in the body of the epididymis be incised so that an artificial reservoir is created. *Elliptical incisions are made in each structure.* A plastic (Silastic) stent attached to a 24-gauge needle assists in the alignment of both structures. Microvascular instruments and a dissecting microscope are helpful.



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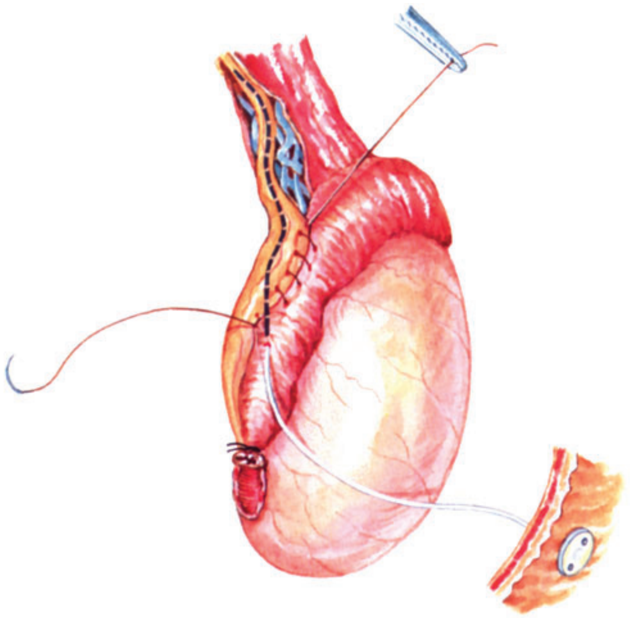


99-2

99-2. *Side-to-side anastomosis is completed* with 7-0 nylon sutures. The needle is removed, and the superior end of the stent is left in the lumen of the vas deferens about 3 cm from the new opening. The inferior end of the stent, attached to a button, is secured outside the skin incision. This allows easy removal of the stent after 12–14 days.

100. Torsion of the Spermatic Cord

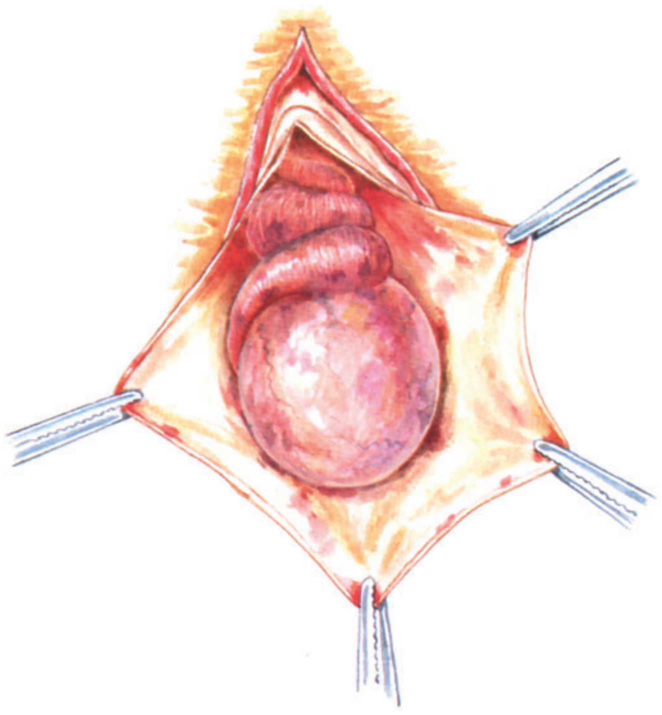
Torsion of the spermatic cord (torsion of the ''testis'') occurs because of faulty embryogenesis that allows free rotation of the testis. It can be a bilateral problem. In the normal male a fascial attachment exists between the testis-epididymis and the inner wall of the scrotum.

The diagnosis of torsion is based on exclusion and a high index of suspicion. Epididymitis in the acute phase will manifest itself as part of an acute or subacute prostatitis. Pyuria will be seen in urine glass 1. Scrotal pain is severe. There may be elevation of the testis on the affected side because of torsion. Radioisotopic imaging studies of the scrotum are useful in making the diagnosis. One would expect to find a good vascular response with technetium pertechnate (^{99m}Tc) or similar isotopes in the normal testicle. A compromised vascular pedicle would show vascular insufficiency by isotope uptake studies.

100-1. A scrotal incision is made and carried through the fascial investments. *The tunica vaginalis of the testis is opened.* The cyanotic, twisted testis may be found. We believe that early exploration within 6–10 hours after onset of symptoms will result in a higher salvage rate of such affected testes.

100-2. *The spermatic cord is untwisted.* If the tunic is adherent to the scrotum, it is freed, and three sutures are placed. The sutures must include dartos if the tunic is mobile.

The contralateral testis should be similarly corrected.



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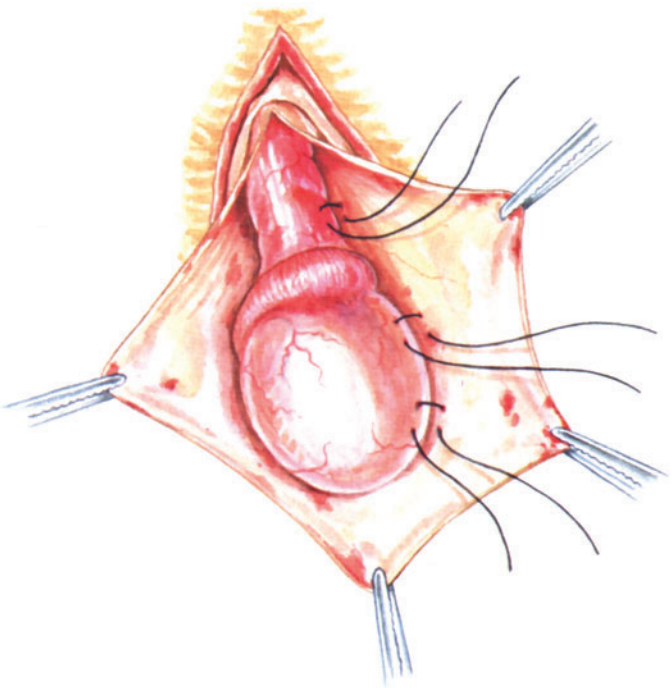

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101. Bilateral Vasovasostomy

The usual candidate for bilateral vasovasostomy has undergone bilateral partial vasectomy 1–8 years previously. He is now married for the second time, often to a younger woman, and the couple desire to start a second family.

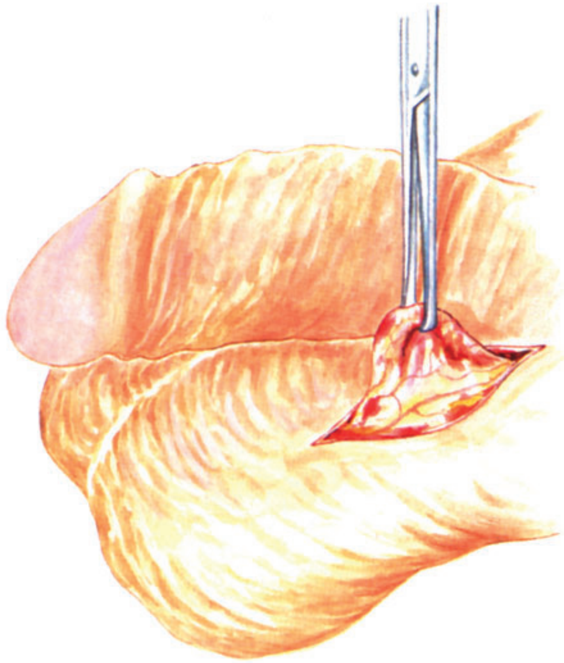
The problem of sperm autoantibodies arising in the male is still unsettled. We have been impressed at the poor semen quality in patients who have undergone vasectomy more than 5 years prior to vasovasostomy. In most instances, the numbers of sperm following surgery are adequate (more than 20 million per milliliter).

Although the procedure is illustrated on the left, a bilateral approach through separate incisions is employed.

101-1. *A skin incision is made over the vas deferens.* An Allis clamp is used to grasp the vas deferens.

101-2. The fibrosed, diseased vas deferens enmeshed in a granuloma is excised. Stay sutures assist in exposing both ends of the remaining vas deferens. Sperm coursing from the epididymis can usually be expressed from the lumen.

101-3. We have devised a silicone rubber (Silastic) stent with a 22-, 24-, or 26-gauge needle glued to each end of small stents in three sizes. Both blunt needles can be used to enter the lumen in opposite directions from each interrupted end of the vas deferens. The plastic (Silastic) button is attached to the stent on the superior side outside the skin by using a special sterilized tube of silicone glue.



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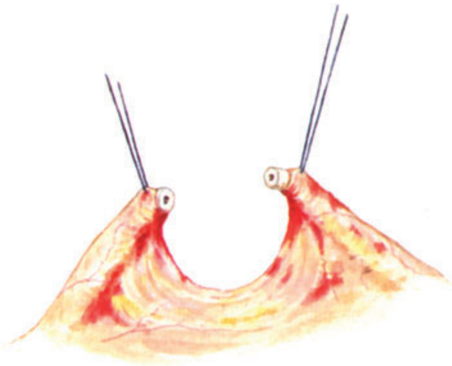

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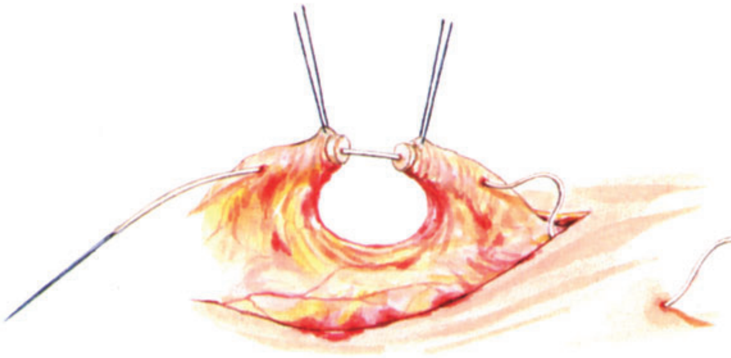

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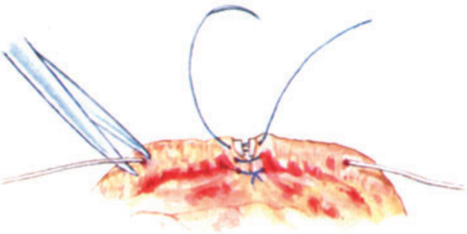

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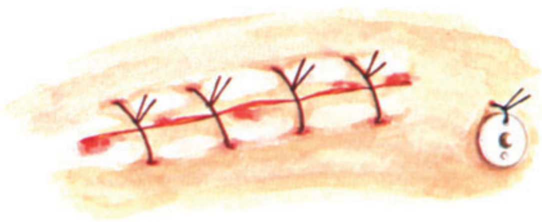

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101-4. *The end of each vas deferens is reapproximated* with 7-0 nylon sutures (four to six). Care is taken to place the sutures at right angles and to include mucosa. The stent on the inferior side is cut just prior to skin closure; the end of the stent is allowed to lie in lumen.

101-5. *The fascial layers and skin are closed separately*. The plastic button is secured to the skin. We keep the stents in place for 12–14 days.

References

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Transurethral Prostatic Resection

8

Transurethral resection is an integral and extremely important part of prostatic surgery. Today the majority of obstructive prostatic lesions are operated upon using this approach.

Although there are two types of transurethral prostatic resection (TURP), cold punch resection and electroresection, the latter is the method employed almost universally and is the procedure usually referred to in relation to TURP.

Modern instruments, providing excellent visualization, permit the rapid resection of tissue and instant coagulation of bleeding vessels by powerful high-frequency currents. The technique of transurethral resection is, however, still one of the most difficult of all urologic operations to master. Moreover, it requires different abilities, plus intensive and prolonged training. The procedure is not simple. The potential exists for many operative hazards and complications when the operation is performed inaccurately and inefficiently by the inexperienced endoscopic surgeon. On the other hand, if carried out skillfully and adequately by a well-trained resectionist, the procedure is better tolerated than an open procedure, especially when the patient is a poor surgical risk. One can expect accurate and more efficient removal of tissue by transurethral resection; the resectionist can remove the surgical capsule or compressed normal lobes of the prostate; these vestiges always remain when the adenomatous hypertrophied prostate is enucleated by open prostatectomy.

In our view, the younger generation of urologists is more enthusiastic about transurethral resection than are their elders. We believe the instruments and operative technique will continue to improve and will make this procedure more accurate and less difficult technically. A recent advancement is the small 3-pound television camera plus TV-videotape apparatus. By attaching the camera to the movable end of the Y attachment which then connects to the resectoscope, a novice can observe transurethral surgery being performed by a more experienced urologist. The observer can watch the TV monitor. The surgeon can replay the tape later and learn from his experience.

Indications and Contraindications

Any type of prostatic obstruction, whether large or small, benign or malignant, can be treated by transurethral resection. Basically, the indications and contraindications for TURP are the same as those for suprapubic or open prostatectomy.

Obstructive carcinoma of the prostate for which total prostatectomy is not suitable is an important indication for transurethral resection. Many patients with advanced carcinoma, however, are relieved of obstruction by conservative endoscopic means.

One of the contraindications for TURP is stricture of the urethra, but the prostate can be successfully resected transurethrally through a perineal urethrotomy, since most urethral strictures are located distally in the bulbous urethra. Another contraindication is a deformity of the pelvis or fixation of the hip joint, prohibiting the introduction of the instrument or the operative movement of the resectoscope to permit adequate visualization of the entire prostate.

Normal bladder function is essential in carrying out TURP. A patient with an atonic or hypotonic bladder due to neurogenic causes cannot expect to regain normal detrusor action following TURP. The obstruction at the bladder neck and the original neurogenic cause must be removed. On the other hand, a hypertonic or contracted bladder with a very low capacity also presents a serious problem during endoscopy, because the period before irrigating fluid fills the bladder is short and the operative time is significantly reduced.

The size of the hypertrophied glands to be removed is an important criterion in deciding whether the transurethral or open surgical approach is employed. As a rule, glands less than 50 g are generally suited to transurethral operation, allowing completion of the procedure within 60 minutes. This interval will generally prevent unfavorable complications such as excess absorption of irrigating fluid.

Recent advances in the operative and postoperative management of the patient, including the use of a nonhemolytic[5,7,8] isotonic irrigating fluid, coupled with the intravenous administration of mannitol[11] containing appropriate amounts of electrolytes has enabled the extension of the operative time to 2 hours. The size of the glands suited to a one-stage procedure approaches 100 g even for the resectionist who has average endoscopic skills.

Patient Preparation

Most patients who require transurethral prostatic surgery are in the older age group; therefore, their general condition requires careful evaluation and examination prior to the operation. Proper attention must be paid to the patient's cardiovascular, respiratory, hepatic, and neurologic systems before transurethral surgery is undertaken.

Prolonged urinary-tract obstruction will produce renal insufficiency. Although repeated catheterization frequently causes urinary tract infection, preoperative catheter drainage is indicated in the presence of a large amount (over 200 ml) of residual urine to improve renal function prior to operation. The drainage system should be closed and aseptic. Irrigation of the drainage system is not necessary unless infection with exudate or calculus formation is found.

Diabetes mellitus must be brought under control before surgery. Particular care is required to stabilize the blood glucose by calculating the amount of insulin required. Precise regulation of the diet must be continued. Overdosage of insulin is the principal danger to the diabetic patient undergoing surgery. Insulin shock may be difficult to distinguish from shock due to blood loss or to excessive dilution of serum electrolytes during or immediately following transurethral surgery. This is especially pertinent while the patient is under general anesthesia. One may allow some glycosuria the day of operation.

When Kimmelstiel-Wilson's disease with renal insufficiency is documented, transurethral resection may be undertaken if the blood urea nitrogen and serum creatinine levels are stabilized at the lower levels (BUN, 35 mg/dl; creatinine, approximately 2.5 mg/dl).

If the patient is receiving anticoagulant therapy for treatment of cardiovascular disease or an old cerebrovascular accident, the medication should be discontinued for at least 5 days before surgery. Hypoprothrombinemia caused by bishydroxycoumarin (Dicumarol) and its derivatives should be corrected by the use of vitamin K.

If the patient has a history of an abnormal bleeding diathesis, or if there is a family history of a bleeding tendency suggesting hemophilia, a complete hematologic work-up should be carried out. Transurethral resection is not recommended in the patient with bleeding tendencies of any type.

A concomitant bilateral partial vasectomy is not a guarantee against postoperative epididymitis. Statistics show that the incidence of the complication is significantly lowered when vasectomy is carried out before TURP.[12,14,17] If a patient needs prolonged preoperative catheter drainage to improve his renal function, it is recommended that bilateral partial vasectomy be performed at the time an indwelling catheter is introduced.

When the necessary preoperative examinations have been completed and the therapeutic measures for preoperative care have been carried out so that his general condition has reached a satisfactory level, the patient is ready for TURP.

A gentle sedative is administered the night before, and an enema is given the morning of operation. For elderly patients, barbiturates should be avoided. If necessary, the enema should be repeated to empty the rectum completely before the patient is taken to the operating room.

Anesthesia

Low spinal or epidural anesthesia is satisfactory for patients undergoing TURP. The patient is kept awake during the operative procedure so that he can alert the doctor to abdominal pain if irrigating fluid extravasates outside the prostatic capsule. He may also complain of nausea and restlessness when large quantities of irrigating fluid are absorbed into the circulatory system.

Spinal anesthesia affords complete bladder and muscle relaxation and causes little postoperative discomfort, nausea, or vomiting. Its main disadvantage is that it may lead to a sudden fall in blood pressure unless pressor substances are administered at appropriate intervals. Sudden changes in blood pressure are hazardous to the patient with cardiovascular disease. Prolonged hypotension may cause renal, myocardial, and cerebral damage.

Epidural anesthesia is probably even safer in the poor-risk patient, since it has little effect on the cardiovascular system. One of the disadvantages of epidural anesthesia is that 30 minutes are required after administration for the anesthesia to have a satisfactory analgesic effect. Therefore, a significant time loss occurs before the operative procedure is begun. Another disadvantage of epidural anesthesia is that it sometimes causes a mild but bothersome penile erection, which elongates the urethra. The tip of a resectoscope may not easily reach the bladder neck in a tall patient. Once anesthesia has been properly induced, satisfactory analgesia and muscle relaxation are achieved.

Disadvantages to the use of general anesthesia are that 1) it does not provide sufficient relaxation without administration of muscle relaxants, and 2) there is an increased risk of respiratory complications. Explosive inhalant gases should not be used in transurethral resection, where high frequency electrical currents are employed. However, for the extremely apprehensive patient, in whom general anesthesia is desired, supplementary general anesthesia with nitrous oxide and oxygen is recommended and complements epidural or low spinal anesthesia.

Instruments and Supplies

Before the operation, instruments and supplies should be carefully checked. The operating table should have a large drainage tray and should be rapidly adjustable to allow elevation or lowering of the patient by a hydraulic or electrical mechanism. The operative chair should also be mobile to allow changes in the position and height of the surgeon.

Two resectoscopes should be prepared in every setup for TURP. A second light source and electrosurgical unit should also be available for rapid substitution in the operating room, in the event of malfunction in any one instrument.

In addition to two resectoscopes and loops, the following accessories and instruments are required for transurethral resection:

1. Drapes and a plastic rectal shield, gloves
2. Male urethral sounds No. 20 through 30 French; lubricating jelly in a medicine glass and a urethral syringe
3. Right-angle and retrospective telescopes that are adjustable to the resectoscope sheath
4. Light cord, power cord, and irrigating-fluid conduit with stopcock
5. Minor surgery tray for vasectomy, meatotomy, and suprapubic drainage; gauze sponges
6. Two Ellik evacuators and Toomey syringes; a basin for filling evacuators with irrigating fluid
7. Indwelling Foley catheters, No. 20 through 26 French, with a 30-ml inflatable bag; a curved stylet and a glass stopper; a 50-ml syringe with adapter for inflating indwelling urethral catheter

The irrigating system should supply fluid on demand and continuously during the resecting procedure. Two plastic fluid-containing bags (3-liter capacity each) suspended from a stand provide a convenient and easily sterilizable irrigating system that is still popular. The use of a factory-bottled nonhemolytic isotonic solution with disposable tubing units is more convenient if an abundant supply is available.

During the resecting procedure, the level of the irrigating fluid is maintained from 50 to 80 cm above the patient's bladder. The pressure should be maintained at the low level; this keeps the operative field clear of blood, because the lower the pressure, the less danger of bladder overdistention. Less absorption of irrigating fluid occurs at lower pressures.

The use of a nonhemolytic isotonic irrigating fluid, such as glycine or a mixture of mannitol and sorbitol (Cytal)[20] is recommended.[7] We prefer the latter fluid. Mannitol is a potent osmotic diuretic and has a protective effect, discouraging acute renal failure when large amounts of irrigating fluid are absorbed. The irrigating fluid should be delivered at body temperature.

The bladder and prostatic fossa are washed with tremendous quantities of irrigating fluid during the endoscopic procedure. If the fluid is cold, the pelvic area and body temperature are lowered, and the patient may be chilled.

Postoperative Management

During the first few hours, constant observation in the recovery room is mandatory. It is important to recognize such possible complications as excessive bleeding, low-sodium syndrome, hypotension, renal insufficiency, and respiratory distress. Blood counts, serum electrolytes, and arterial blood gas levels should be monitored in the poor-risk patient as soon as the endoscopic procedure is completed. The data should be compared with preoperative levels, and appropriate therapy should be started.

In the immediate postoperative period, the patient should be free of pain except for mild discomfort in the urethra, occasionally accompanied by a desire to void. Ordinarily, a new severe pain is a sign of a complication that must be treated immediately. In most cases, it is a symptom of bladder distension due to catheter obstruction with blood clots; it may also signal a perforation of the prostatic capsule or bladder wall. Prompt action should be taken to treat the appropriate problem. If untreated, it may progress to a significant degree. Excessive blood loss should be replaced with blood transfusions. Appropriate amounts of 5% sodium chloride should be added to the intravenous fluids to correct hyponatremia.[8,9]

The necessity for using a urethral catheter means postoperative urinary infection will develop almost inevitably. Therefore frequent bacteriologic culture of the urine is required. Postoperative infection of the bladder, prostatic fossa, and urethra is usually mild and can be controlled by use of appropriate antimicrobial drugs. Maintenance of a high fluid intake and removal of the indwelling catheter at the earliest opportunity help minimize infection.

When urinary infection exists prior to operation, culture and sensitivity tests are performed to identify the invading organism. Appropriate antibiotics should be started before and continued during the transurethral procedure to treat the existing infection.

Catheter care to keep the lumen open and draining is an important principle of postoperative care. When the patient is well hydrated, there may be a steady drip of clear or blood-tinged urine from the catheter. This indicates that there is no undue hemorrhage and that hand irrigation is unnecessary. We prefer to use the regular straight-drainage closed system in such cases. If, on the other hand, there is either intermittent flow from the catheter or a flow of bloody urine, irrigation of the catheter and evacuation of blood clots in the drainage system and bladder are necessary.

Frequently, postoperative hemorrhage may be controlled adequately by evacuating blood clots from the bladder and prostatic fossa; this allows contraction of prostatic capsule and bladder neck which, in turn, discourages further bleeding. Use of a continuous irrigation system with a three-way catheter, 22–24 French, is sometimes quite useful.

The traction of an indwelling catheter (50- or 60-ml bag) against the bladder neck is also helpful in controlling undue bleeding from the bladder neck and prostatic fossa. Care must be taken not to inflate the hemostatic bag excessively. If it is inflated with more than 70 ml water, the tip of the catheter may be elevated at the dome of the bladder, which disturbs the smooth return of irrigating fluid.

As a rule, patients are permitted out of bed the day after transurethral resection, unless there is a danger of excessive bleeding. It is advisable to have the patient out of bed, sitting quietly in a chair. The patient is permitted to walk as soon as the danger of hemorrhage has passed.

The indwelling catheter is removed in 3 or 4 days, when macroscopic hematuria has disappeared. Too early removal of the catheter sometimes encourages significant hemorrhage.

The patient is ready to be discharged from the hospital on the day following removal of the catheter. He should be afebrile and voiding clear or slightly blood-tinged urine without difficulty. Periodic examination of the urine should be continued at the outpatient clinic or office as long as the urine is infected. Appropriate antimicrobial drugs are administered as needed.

Orientation with the Resectoscope Lens

Complete observation of the bladder neck and prostatic urethra should be accomplished, and all landmarks, including ureteral orifices, should be well visualized before resection is started. The safety of this operation depends upon constant identification of all important landmarks in the operative field. Only pathologic tissue is resected; other structures are spared. Routine use of an obliquely forward visual telescope system (Foroblique) is very helpful for a beginner. Experience will facilitate rapid and accurate identification of all landmarks in bladder and urethra.

The important landmarks (Fig. 1) seen with the foroblique telescope lens in patients with prostatic hypertrophy are as follows.

1. Vesical trigone, right and left ureteral orifices
2. Intravesical median lobe
3. a. Both lateral lobes and median lobe at the prostatovesical junction
   b. Junction of lateral lobes in the 12 o'clock position
4. Hypertrophied lateral lobes as seen between the bladder neck and verumontanum.
5. Verumontanum and intruding lateral lobes at the lower posterior surface of the prostatic urethra
6. External sphincter at the membranous urethra
7. Bulbous urethra

When significant prostatic hypertrophy with marked intravesical protrusion exists, there will be a considerable blind area. The ureteral orifices may not be identified with the foroblique telescope lens.

The verumontanum is the most important landmark by which the surgeon can be assured that resection is close to the external sphincter. It is found by withdrawing the telescope until the rounded prominence is seen on the posterior floor of the prostatic urethra.

The external sphincter is just distal to the verumontanum. It is a pleated circular band that wrinkles when the telescope and sheath tip are pushed forward and backward. Accurate identification of this point is very important to ensure that resection does not damage the external sphincter when resection is concentrated close to apical tissue at the verumontanum.

Position of the Patient and Preparation of the Operative Field

After satisfactory anesthesia is obtained, the patient is placed in a lithotomy position on the operating table. An indifferent electrode is placed beneath the buttocks. The patient's knees should be widely spread to allow adequate space between them for manipulation of the resectoscope. The thighs should be at a gentle angle with the body to avoid elevating the pelvis. If the thighs are flexed at an acute angle, the prostate is displaced

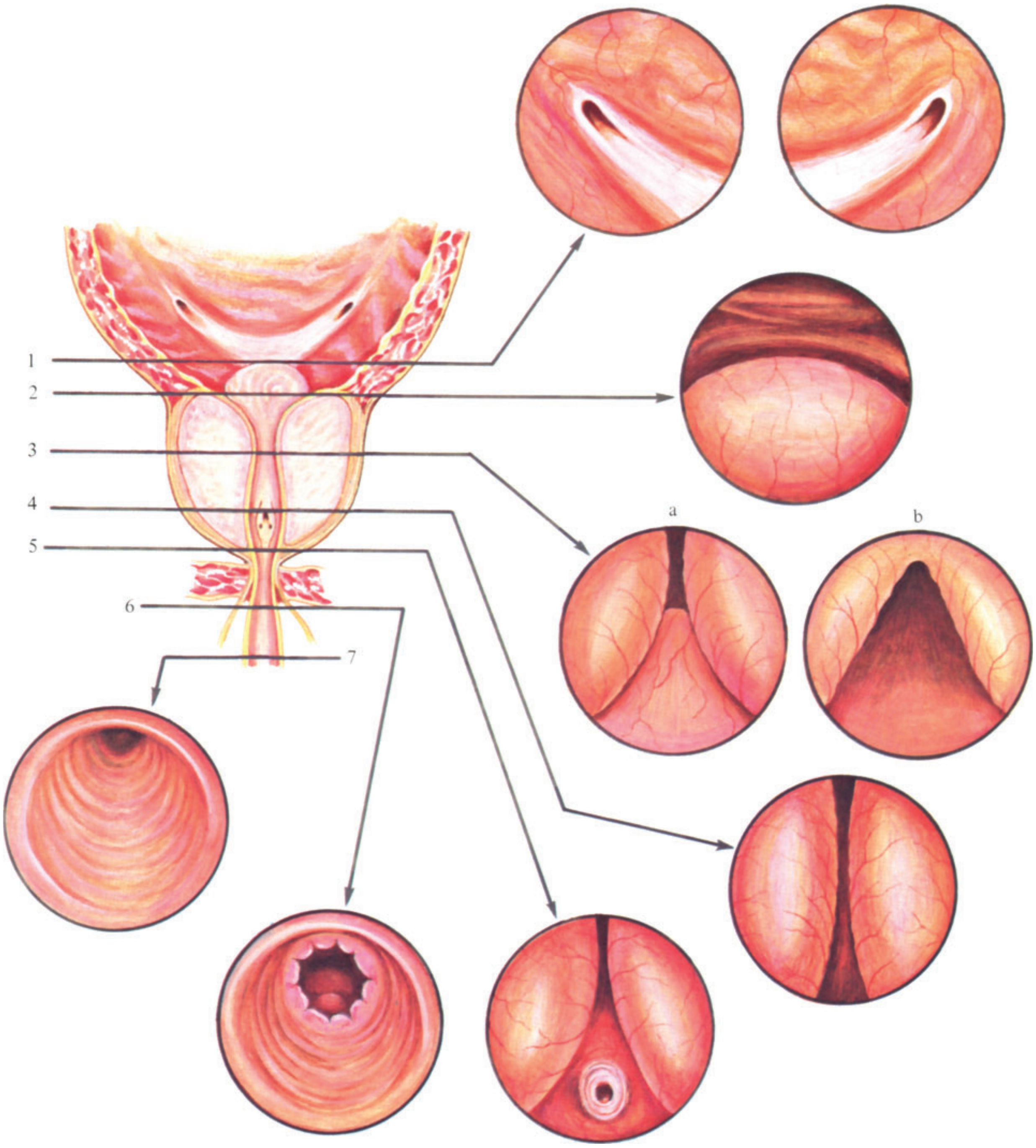


FIG. 1. Landmarks in patients with prostatic hypertrophy, as seen with the telescope lens.

downward into the perineum; during surgery the resectoscope is then tilted upward in an awkward position, and this location prevents smooth manipulation of the resectoscope along the horizontal plane.

The lower abdomen, penis, scrotum, and perineal area are well cleansed with soap and antiseptic solution.

The plastic rectal shield is applied over the perineum with its finger cup well lubricated with a sterile surgical lubricant. The finger cup is inserted into the rectum.

The operative field is draped; the power and light cord are connected to their source. All other instruments are checked and placed in working order before the operation is started.

Preliminary Accessory Urologic Procedures. After bilateral partial vasectomy,[12,14,19] or immediately after the patient is draped if vasectomy is omitted, the urethra is well lubricated with a water-soluble jelly. Urethral calibration and dilatation are performed with curved urethral sounds (24–30 French). If a 30 French sound can be passed easily, the surgeon may choose a 28 French resectoscope sheath for resection of significant prostatic hypertrophy. When urethral calibration is snug to a 28 French sound, a smaller sized sheath, 26 or 24 French, is selected according to urethral size.

Urethral dilatation by means of a curved metal sound is helpful when mild urethral stenosis disturbs the free passage of a resectoscope sheath. After the urethra is dilated to the size of a 26 French sound, there will be no difficulty in performing transurethral resection with a 24 French resectoscope sheath.

Frequently a narrow external urethral meatus causes difficulty in introducing the resectoscope sheath. External meatotomy is performed by cutting the ventral aspect of the urethral meatus in such cases. It is important to suture the divided urethral mucosa to the adjacent mucosa of the glans penis. If the incision is left open, a more severe stenosis will recur when healing takes place.

When a long urethral stricture or unusual narrowing of the entire anterior urethra is encountered, transurethral resection can be performed through a perineal urethrotomy. It is performed by cutting down vertically on a urethral sound at the perineum. A filiform and follower can be used to identify the bulbous urethra. When the incision is extended into the urethral lumen, anchor sutures are placed through the bulbocavernosus muscle and wall of the urethra on each side. Through this opening the resectoscope sheath can be introduced without difficulty into the prostatic urethra and bladder.

Operative Techniques

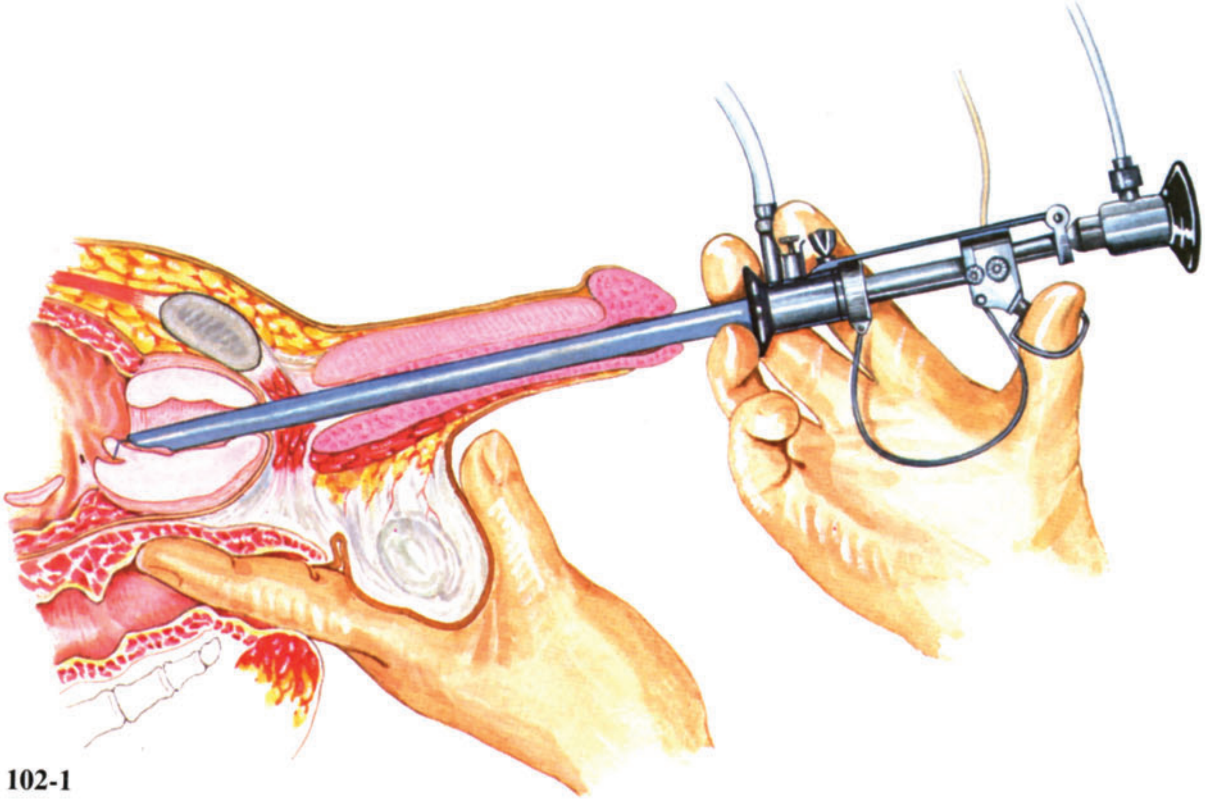
The surgeon will have decided upon a well-organized plan prior to starting the resection. Proper strategy will allow a satisfactory operative result in the allotted time. Resection of a piece of tissue from one lobe and then the opposite lateral lobe of the prostate is not an efficient method of performing transurethral resection. Although several efficient operative strategies have been described by excellent resectionists,[1,2,4,6,15,18,22,23] our favorite plan is introduced herein.

102. Transurethral Resection for Prostatic Hypertrophy

102-1. After *the resectoscope sheath is introduced through the external meatus or perineal urethrotomy,* the Timberlake obturator is removed, and the inflow line is connected to the one-way stopcock on the metal rim of the sheath. Then the working element equipped with a cutting loop and the oblique telescope is introduced and locked into the sheath. Light and a power cord are connected to the resectoscope.

102-2. *The "landmarks" are now identified.*

102-3. The surgeon starts to *resect at posterior bladder neck between the 4 and 8 o'clock positions.* The median lobe is removed down to the midprostatic zone, and the elevated bladder neck is resected until the circular fibers of the internal sphincter are fully exposed.



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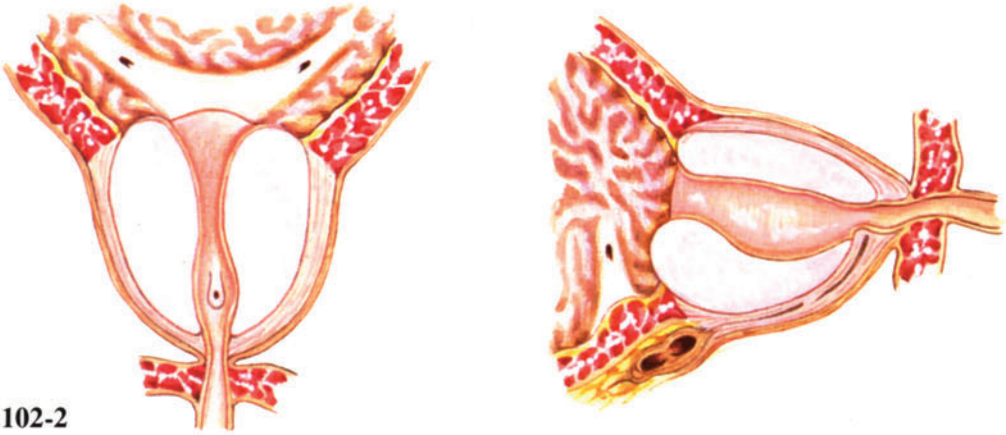

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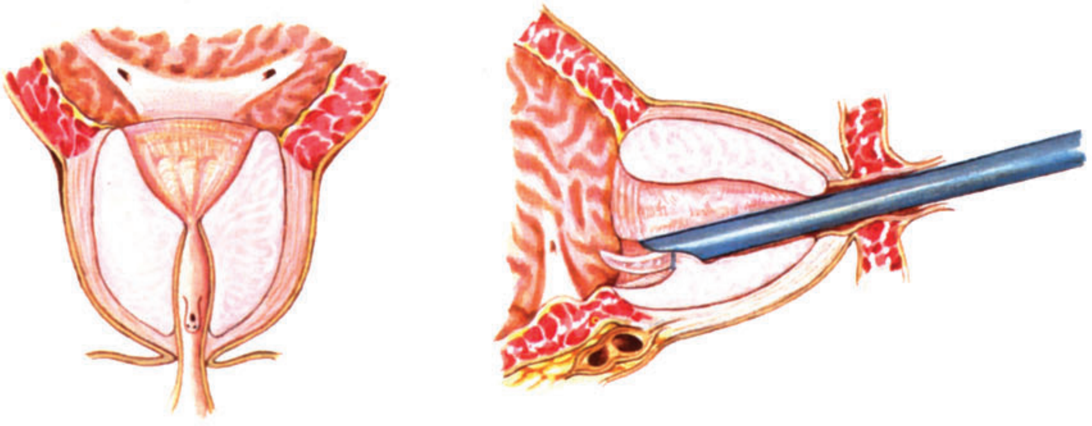


102-3

This initial manuever cuts off some of the main blood supply to the median and lateral lobes at about the 4 and 8 o'clock positions. Careful coagulation of these bleeding points makes further resection of these lobes easier and bloodless.

After this area is flattened, irrigation of tissue fragments into the bladder cavity during the resecting procedure allows the surgeon to obtain a good endoscopic view.

Another advantage of beginning the resection at the posterior portion of the bladder neck rather than at its anterior portion is the greater number of important landmarks existing in this area. Finishing the resection of this area with a clear view in the very beginning of the operation is a great advantage; it helps the surgeon to avoid injuring the trigone and ureteral orifices and cutting too deeply into the circular internal sphincter fibers.

After this initial step is completed, the surgeon returns to this area only for coagulation of bleeding points, not for cutting.

102-4. *The anterior commissure is resected.* After the first few pieces of tissue are resected, the anterior commissure will widen laterally as the tops of the lateral lobes drop down to either side. After this step, resection of the lateral lobes is initiated, each lobe being resected separately.

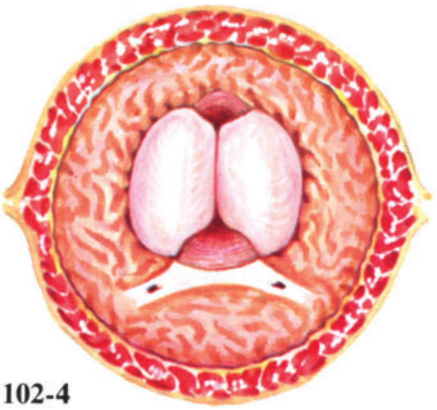
Making the furrow at this point usually produces little anterior adenomatous tissue, and with one or two sweeps of the loop the circular fibers of the bladder neck are exposed. It is helpful to establish this valuable landmark at the early stage.

102-5, a and b. *The main part of each lateral lobe is resected from the bladder neck to the level of the verumontanum.* Each side of the lateral lobe is thoroughly resected, and the bleeders are coagulated. The surgeon does not move to the opposite lobe until all the active bleeders are stopped and the return of irrigation fluid becomes almost bloodless. This precaution obviates a search of the entire operative field when active bleeding occurs during resection of the opposite lobe.

When resection is completed to this stage, the widely opened prostatic fossa comes into view in front of the verumontanum.

If the patient is a poor risk or in the older age group, the surgeon may stop the operation. Satisfactory clinical results usually can be expected when the resection is carried out to this point.

102-6. *The resection is completed by removing the remaining tissue around the verumontanum and prostatic apex.* This is the most critical



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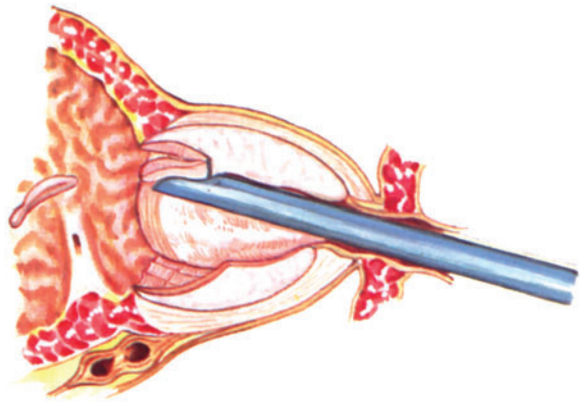

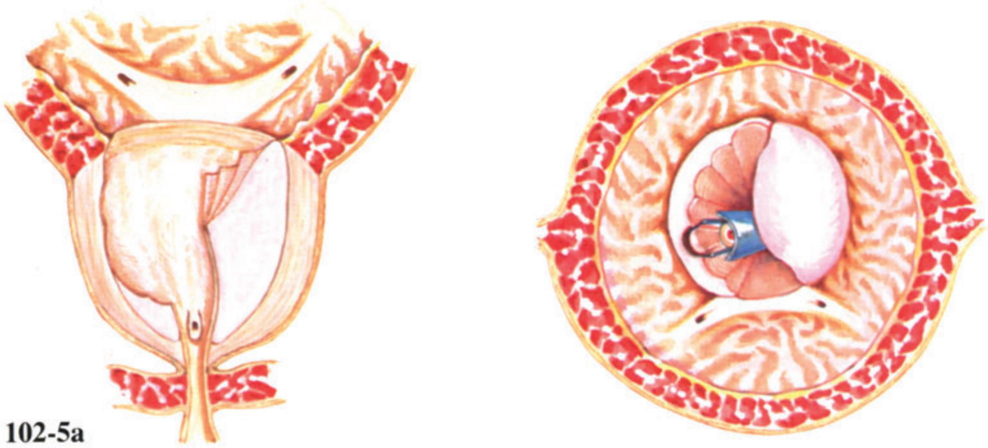

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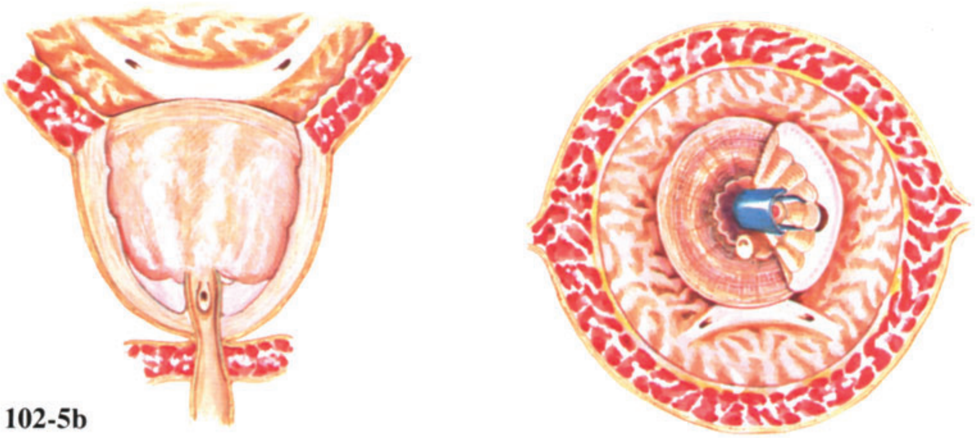

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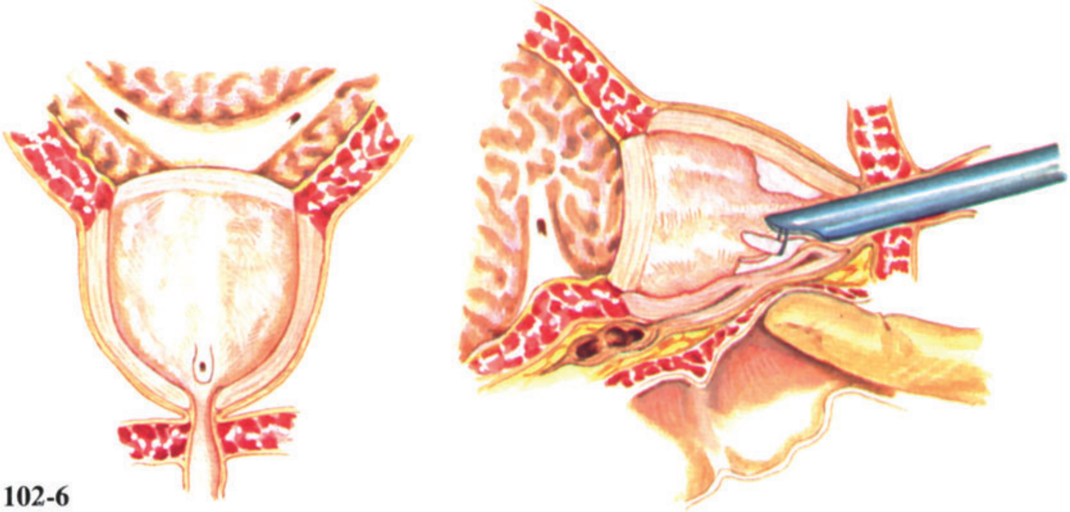


102-6

step of the whole procedure and great care is taken to judge the correct amount of tissue to remove. The adenomatous tissue may extend beyond the verumontanum both anteriorly and laterally; therefore the correct identification of the external sphincter is of utmost importance. The surgeon frequently draws the resectoscope sheath back toward the membranous urethra to identify the external sphincter before resecting the apical tissue.

The membranous urethra is a fixed structure situated at the urogenital diaphragm whereas the prostate gland, which abuts on this diaphragm, is slightly movable. When the prostate gland is moved by manipulating the resectoscope sheath back and forth, the mucosa bridging the junction is plainly visible as it is thrown into a fold, like an accordion. This wrinkle should never be resected or coagulated. It overlies the external sphincter.

A useful hint in resecting apical tissue is to cover a finger with a plastic shield for protection and insert it into the rectum; the finger can displace tissue medially or upward. The surgeon is able to palpate the resectoscope sheath through the rectum and can be assured that the cutting tip is in the safety zone and not at or in the membranous urethra.

When the resection progresses to the true glandular or posterior lobe, the fuzzy or cotton-like appearance of the adenoma gives way to the smoother and patterned structure of true prostatic tissue, which does not bulge into the operative field. However, the change is not distinct, and usually it is difficult to differentiate true prostatic tissue from adenomatous tissue unless the resection continues close to true capsule.

In some cases a layer of prostatic calculi helps to identify the plane between adenoma and true prostatic tissue. The calculi usually lie either between the adenoma and true prostatic tissue or in the superficial layer of the latter. All tissue containing calculi should be removed; care is needed not to resect too deeply to reach the true capsule.

It is wise to stop resecting when true prostatic tissue is identified. Troublesome, multiple fresh bleeders from capsular vessels and venous bleeders are frequently encountered close to true capsule. Unroofing of the capsule is not an indication to stop the resection but is a warning to proceed no deeper in that particular area. It is also a guide to the depth of the capsule in the adjacent areas.

When the resection is completed, no fuzzy-looking adenomatous tissue remains in prostatic fossa, and the important landmarks, such as the ureteral orifices, verumontanum, and external sphincter, should be visible and intact.

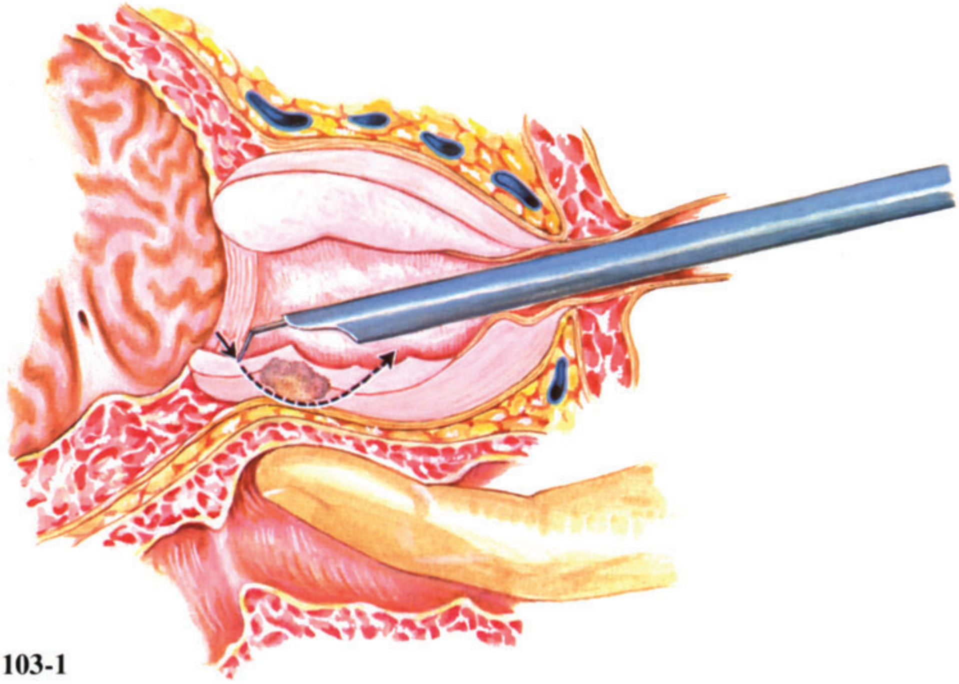
103. Cancer of the Prostate

A patient with curable cancer of the prostate without demonstrable metastases or fixation of the gland should not undergo transurethral surgery as a rule. However, a small nodule in the prostate, palpable by rectal examination, can be resected.

103-1. *A small nodule in the prostate is resected by the transurethral approach* and can serve as a biopsy specimen.

103-2. Prostatic cancer is somewhat yellowish on gross examination and appears coarsely granular and friable. When a small cancerous nodule is successfully resected along with the surrounding normal tissue, *true capsular fibers are exposed;* total prostatectomy can be postponed until recurrence or another nodule is detected.

The main purpose of transurethral resection of prostatic cancer is to provide a channel for urination through the prostatic urethra by resecting obstructive cancer tissue.[16] When the lesion is beyond the borders removable by total prostatectomy, with local invasion and metastases, transurethral resection is the treatment of choice. Hormone trials are always warranted to relieve obstruction.



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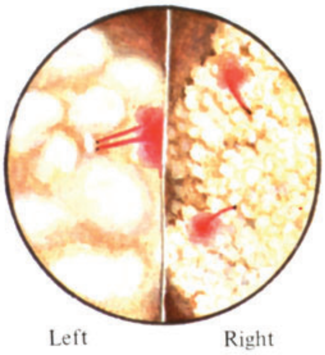

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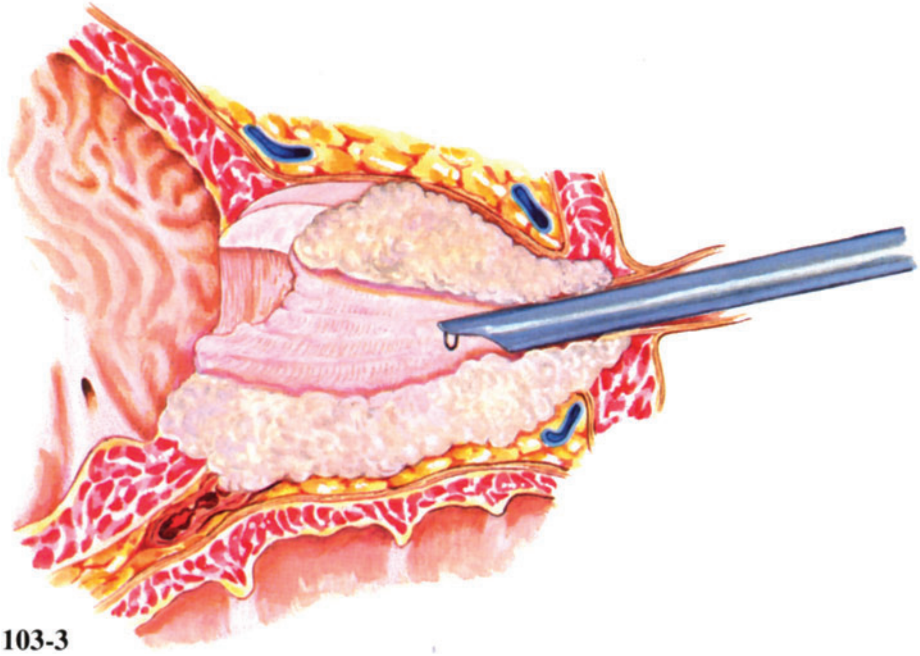


103-3

Obstructive cancer tissue is more difficult to resect than benign adenoma. First, the hard and nonelastic cancer tissue disturbs the smooth cutting movement of a resectoscope. Sometimes the sheath is tightly fixed in the prostatic urethra and only a thin superficial layer is resected by the cutting loop. Second, the true capsule of the prostate is frequently involved with cancer; therefore a very important landmark is missing, and further resection is hazardous. Third, the verumontanum and external sphincter are frequently involved with cancer. Resection of tumor tissue in this area will cause postoperative urinary incontinence.

103-3. *Resection of obstructive prostatic cancer should cease when a satisfactory channel is made* in the prostatic urethra. Recurrence of obstructive symptoms is rather rare if estrogen or antiandrogenic therapy is continued after the operation.

104. Hemostasis

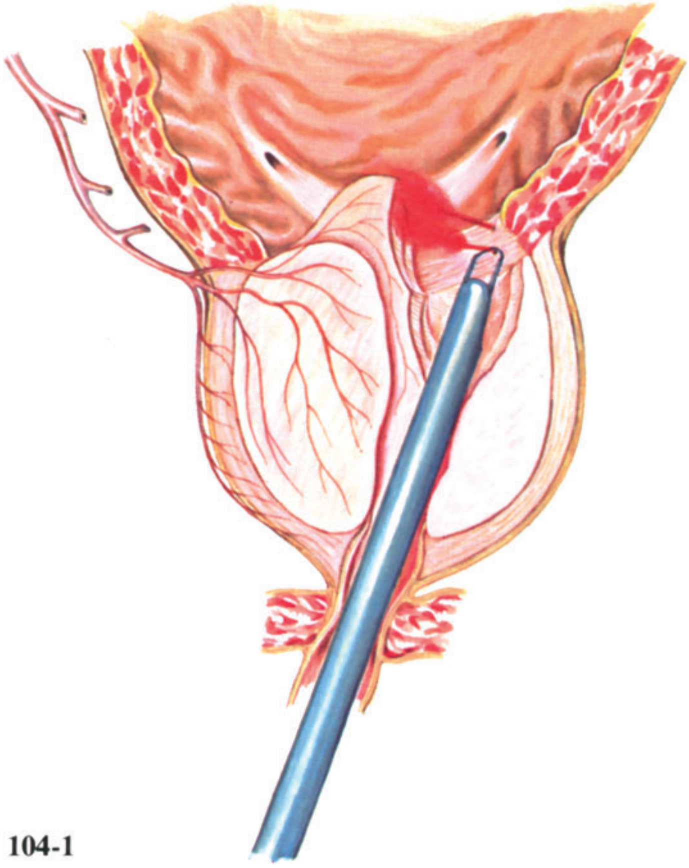
The most troublesome problem during transurethral resection is bleeding. As large areas of prostatic tissue are resected, the visual field of the telescope is frequently obliterated by arterial bleeders. This is very stressful to a neophyte resectionist, and will be discouraging in the early years. However, no arterial bleeder exists that cannot be controlled by fulguration in the operative field.

The protruding stumps of the arterioles usually contract with their thick muscular wall and can be coagulated without difficulty, if the loop is pointed correctly over them. Extensive electrocoagulation over a large area, however, is damaging to normal tissue and is usually ineffective in controlling hemorrhage.

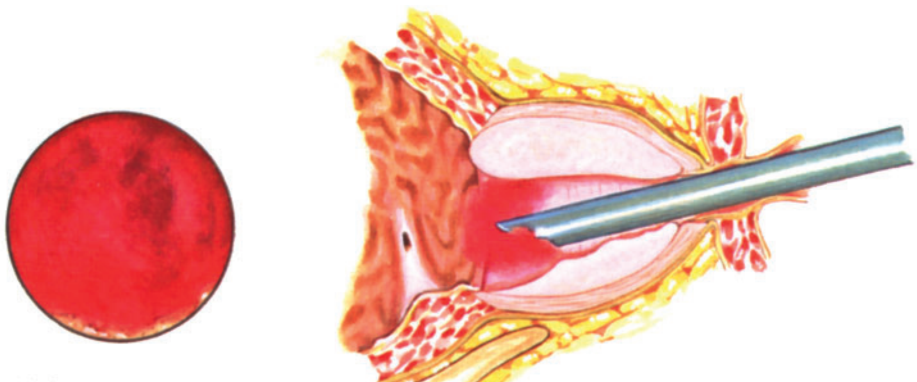
A surgeon who becomes flustered may become disoriented and may not see the bleeding sources. However, once the surgeon gains self-confidence in the proper hemostatic technique, resecting ability will progress. The following hints will be of great assistance in learning proper hemostatic technique.

104-1. *Stop the main bleeders at the vesical neck first.* The most important vessels to the prostate enter the lower quadrants of the vesical neck, at about the 4 and 8 o'clock positions. If they are coagulated at the early stage of the operation, large areas will be devascularized. This will minimize the bleeding thereafter, and will provide a better view to the surgeon.

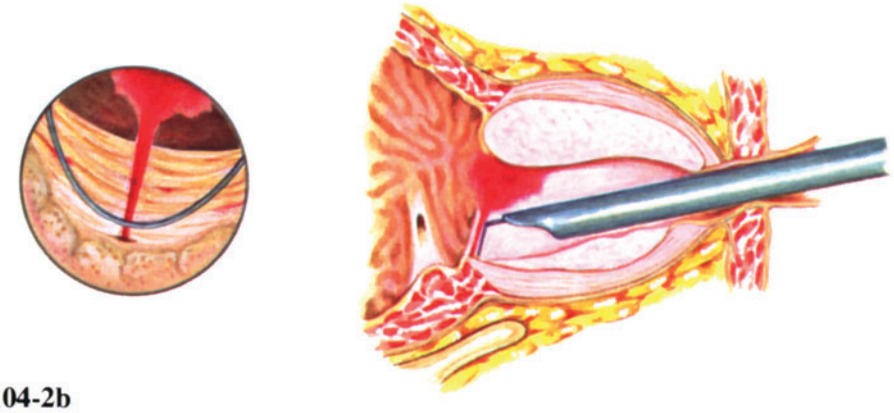
On the contrary, when a large arteriole is encountered during the resecting procedure, the surgeon is advised to return to the freshly resected area to search for arteriolar bleeders.



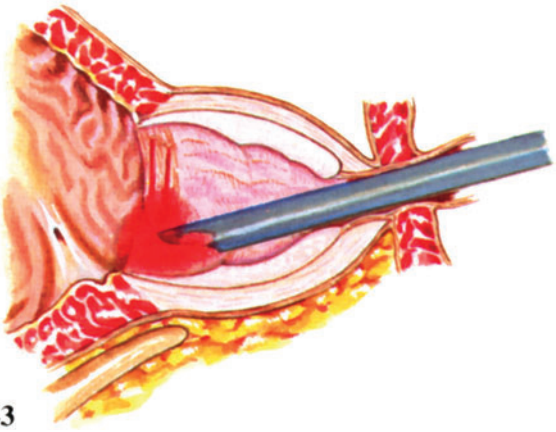
104-1



104-2a



104-2b

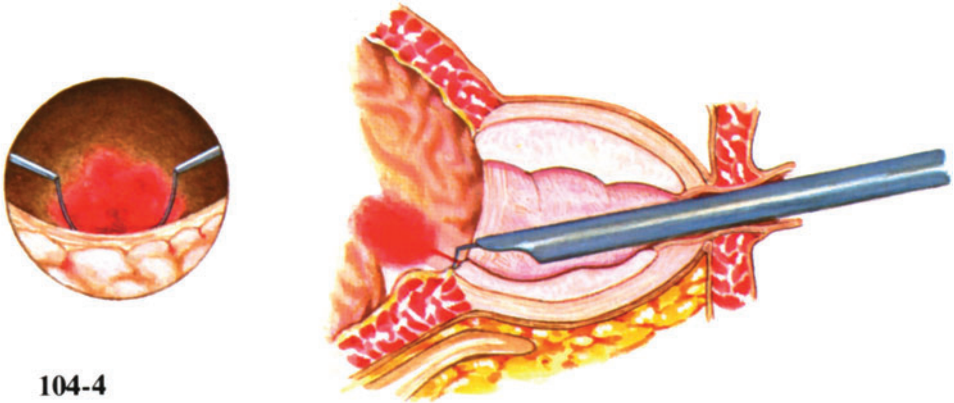


104-3

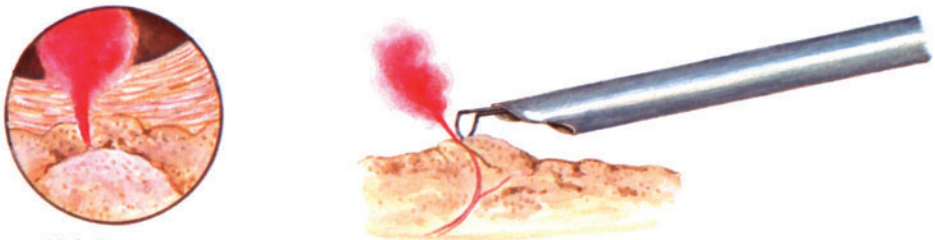
104-2. Search for bleeding points along the resected surface. *Arterial bleeding cannot be localized when an artery is spurting directly at the lens* (a), *but is easily seen in profile* (b). One must advance the lens of the resectoscope very close to the resected surface of the tissue until the spurting vessel is seen in profile. Cessation of bleeding is immediate when the coagulating current is applied to the loop placed exactly on the arterial stump.

104-3. *Beware of the opposite side.* Occasionally blood from an artery spurts across the prostatic fossa, rebounding at the opposite side, making it appear that the source of bleeding is from the area of rebound. The surgeon should direct attention to the opposite side when a vague, nonlocalizable wall of blood appears without any obvious source.

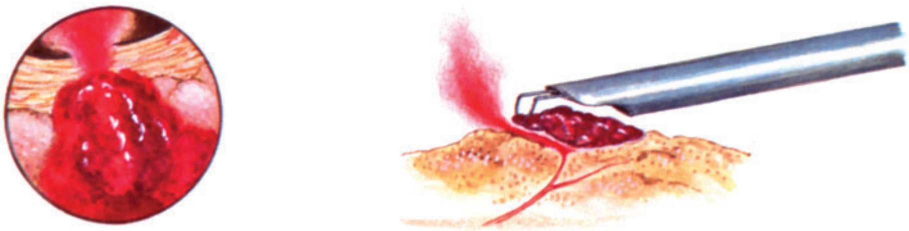
104-4. Arterial bleeding behind the vesical neck, spurting toward the bladder cavity cannot be detected with the oblique telescope. It is seen as a vague nonlocalizable show of blood behind vesical neck. *Careful coagulation of the suspected area behind the vesical neck will be successful.*



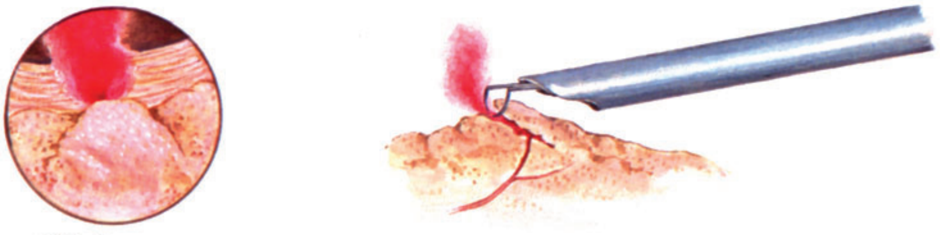
104-4



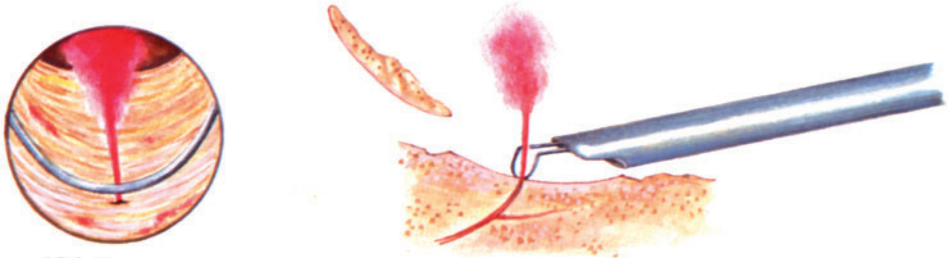
104-5a



104-5b



104-6



104-7

Localizing a Direct Bleeding Point. The best time to control a bleeding artery is immediately after the cut that started it. However, if the surgeon is working rapidly to remove a large adenoma, bleeding will later be more difficult to localize.

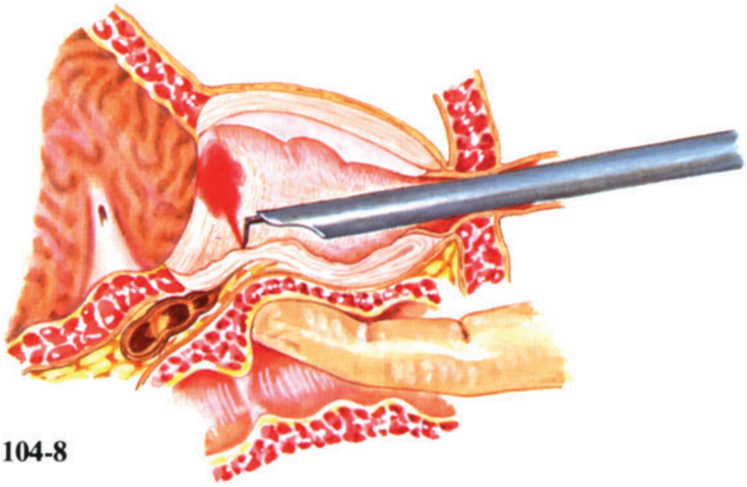
104-5. Sometimes *tags of tissue or blood coagula* (a) that project in front of the resectoscope lens *obscure the bleeding point* (b).

104-6. At times, *the cut end of a spurting artery is located in a split tissue cleft*.

104-7. *When a shallow resection is made in this area, the bleeding point is easily seen* on a clean, shining, cut surface, and can be readily coagulated.

104-8. *Use the other hand as an aid in the operation.* Rectal elevation of the prostatic fossa with the index finger of the left hand is sometimes helpful in localizing bleeding points after removal of a large adenoma. When the finger is pressed firmly against the bleeding point the spurting stops; when it is released, it spurts again.

104-9. *Compression of the suprapubic area is also a helpful technique* in coagulating bleeding points at the anterior bladder wall near the neck. Use of the one-hand resectoscope is recommended for these techniques.



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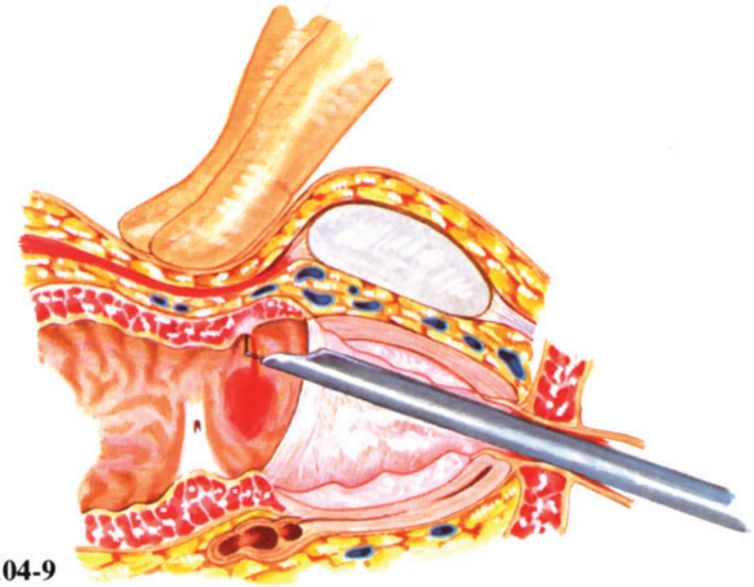


104-9

104-10. *Do not resect too deeply into the true capsule.* The best result of transurethral resection of the hypertrophied prostate is obtained when the adenoma is completely removed. Most of the surgical capsule remains untouched. When resection proceeds beyond adenoma, numerous small bleeders from the capsular group of arteries may occur, an indication that the resection has been carried far enough. If one extends to the true prostatic capsule, there will be more troublesome minor bleeders and a greater chance of unroofing venous sinuses.

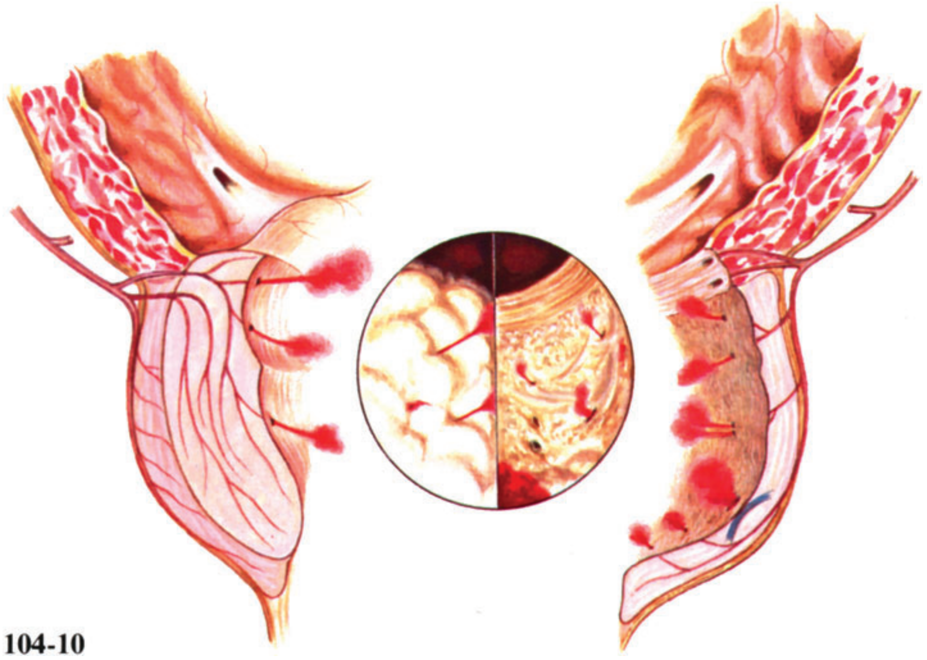
In addition, the cut ends of arterioles at the true capsule are frequently buried between capsule fibers, making the bleeding points difficult to identify. Intense coagulation of the true capsule may lead to perforation of the capsule and subsequent leakage of irrigating fluid into surrounding tissue.

Do not attempt to coagulate venous bleeders. Bleeding from veins is easily identified since it does not spurt like arterial bleeders. It ceases with a slight rise of intravesical pressure. It is not necessary to coagulate minor venous bleeders, since they usually stop spontaneously after completion of transurethral resection.

Bleeding from venous sinuses cannot be controlled by electrocoagulation. It persists in spite of extensive coagulation directly on the venous sinus walls. Continued coagulation may enlarge the opening and produce more profuse hemorrhage with further extravasation of irrigating fluid into the bloodstream.

If blood pours out of the working sheath when the resectoscope is removed, yet bleeding ceases when the bladder is distended with irrigating fluid, the source of bleeding is usually the unroofing of a venous sinus. Bleeding from venous sinuses, however, is easily controlled by slight tension on a Foley catheter with the bag inflated which is inserted after coagulation of spurting arterial bleeders.

Check the level of blood pressure. Hypotension must be evaluated. In the control of bleeding at the termination of transurethral resection, the surgeon should be aware of any change in the patient's blood pressure. When the blood pressure is maintained at a lower level because of excessive blood loss or spinal anesthesia, bleeding from the operative field is much less, and the surgeon may be deceived into thinking hemostasis is



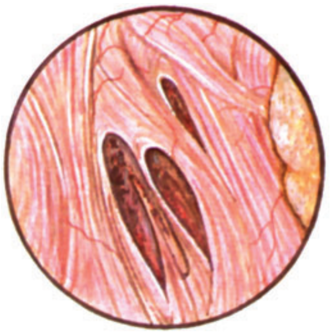
104-10

satisfactory. However, if the patient's blood pressure rises after completion of the operative procedure, bleeding will increase and bleeders that previously stopped may start again. Therefore, it is recommended that the anesthetist raise the patient's blood pressure to the preoperative level. This maneuver allows inspection of the entire operative field again before the endoscopic procedure is terminated.

105. Prostatic Capsular Perforation

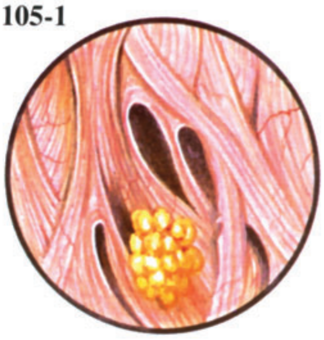
A small perforation of the prostatic capsule or vesical neck may occur when an adequate transurethral resection is under way. This window will permit small amounts of irrigating fluid to enter the periprostatic tissues and venous channels. However, this complication will rarely give rise to difficulty if care is taken to avoid enlarging the perforation by continuing the resection or by overdistending the bladder with irrigating fluid. If there is no clinical evidence of suprapubic pain and muscle rigidity, the operation can continue.

A capsular perforation in the early stage of the operation can occur at the vesical neck or trigone where a depth of one or two bites with the cutting loop may penetrate the wall. Perforations in the late stage of the operation usually occur when the resection has advanced close to the true capsule of the prostate. This may occur in a large adenoma when the capsule is very thin.



105-1

105-1. The capsule consists of a meshwork of interlacing fibers and can be easily recognized by its characteristic appearance. *When the capsule is scraped, the fibers separate widely and the interstices are more marked.*

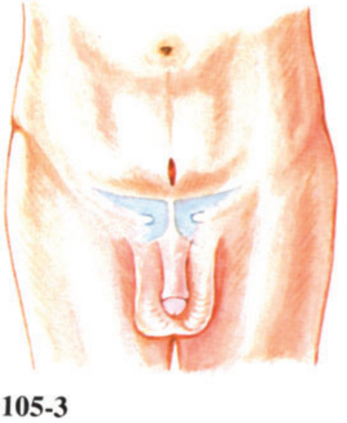


105-2

105-2. *If a perforation is deeper, a dark cavity comes into view between the coarse fibers, and pericapsular fat may be seen through the opening of the perforation* or may even protrude slightly into the prostatic fossa. When a perforation occurs, large amounts of irrigating fluid containing blood and tiny tissue fragments may be extravasated into the surrounding tissues. This complication is characterized by gross interference with the free exchange of irrigating fluid through the sheath when the working element is removed.

A patient with a spinal or epidural anesthesia will complain of pain in the suprapubic region, which does not disappear on emptying the bladder. If a patient is under general anesthesia, there will be no complaints of pain. However, rigidity of the lower abdominal muscles and distention of the lower abdomen are confirming signs of definite extravasation. If one is uncertain about the occurrence of perforation, a cystogram using an innocuous radiopaque medium and an emptying film are of great value. When a deep perforation accompanied by clinical signs occurs, immediate suprapubic drainage is indicated. Spurting arterial bleeders are then coagulated and a hemostatic Foley catheter with bag is inserted. Mild traction is applied to control other bleeders.

A delay in these emergency measures will lead to extravasation of a large volume of irrigating fluid, and the patient may develop shock and acute signs of distress.

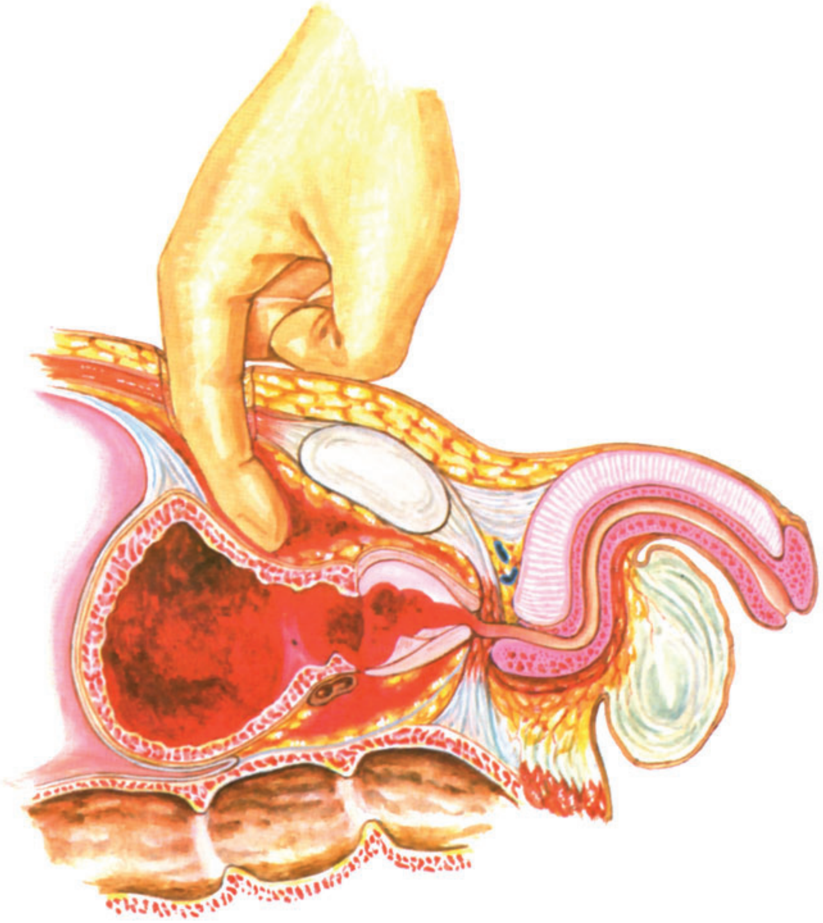


105-3

105-3. *Suprapubic drainage is usually performed thro*
sion in the midline just above the symphysis pubis.

105-4. The fascia is incised; the rectus muscles are slightly separated, and *the perivesical space down to the region of the prostate is opened by blunt dissection with a finger.*

105-5. *Soft rubber Penrose drains are inserted.* This may be done on the operating table or in the recovery room as soon as the diagnosis is confirmed and while the anesthesia is still effective.



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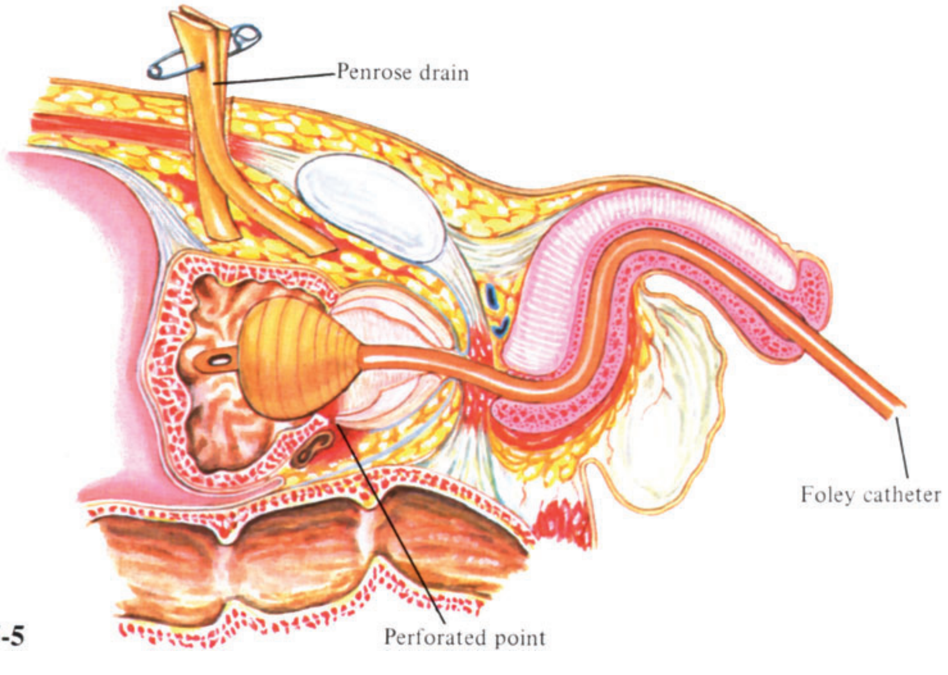


105-5

Unless there is profuse bleeding, which requires open hemostasis or packing of the prostatic fossa through a cystotomy, suprapubic drainage is adequate. However, if there is suspicion of intraperitoneal extravasation due to perforation of the bladder wall, the peritoneum should be opened for inspection in the operating room. The peritoneal cavity is emptied by suction, and the perforated wound is closed with a running 2-0 chromic catgut suture.

106. Systemic Complications due to Absorption of Irrigating Fluid

The nonelectrolytic isotonic solutions, such as glycine or a mixture of mannitol and sorbitol, are routinely used nowadays as irrigating fluid for transurethral resection.[11] These are safe fluids and do not cause hemolysis.[5] However, their use may give the surgeon a false sense of security.

106-1. *The rapid transfer of large amounts of irrigating fluid to the bloodstream* during transurethral resection *will produce systemic complications* such as hypervolemia and hyponatremia, as well as diluting other body fluid electrolytes.[8,9,13] Hypervolemia probably causes a preliminary rise in blood pressure before the patient manifests a symptom complex due to hyponatremia, consisting of restlessness, nausea, vomiting, bradycardia, and agitation. Some of these symptoms are possibly due to cerebral edema. Generalized muscle weakness then appears, but in some instances muscle cramps may occur, probably as a result of hypocalcemia.

If the operation is prolonged and there are additional complications, such as excessive hemorrhage and prolonged anesthesia, the patient will develop circulatory failure. A serum sodium of 120 mEq/liter is conducive to shock. Hyponatremic shock is not easily reversible and may result in acute renal failure.

It is wise, therefore, if the operation is prolonged, to determine serum sodium and hematocrit levels during the operation.

Central venous pressure monitoring[13] is also a helpful method of assessing hemodynamic changes during the operation. The severity of the hypervolemia and its associated hyponatremia are directly related to the amount of irrigating fluid entering the venous system through the open venous sinuses.

The intravesical pressure depends on the height of the irrigating fluid. Irrigating fluid with a hydrostatic pressure of 60 cm can easily be forced into a venous system registering 15 cm of water pressure. Therefore, a lower irrigating fluid height and frequent emptying of the bladder are recommended. Using the Iglesias continuous flow resectoscope[10] may help to avoid bladder overdistention. It allows continuous resection under clear vision without the need for periodic evacuation of bloody irrigating fluid.

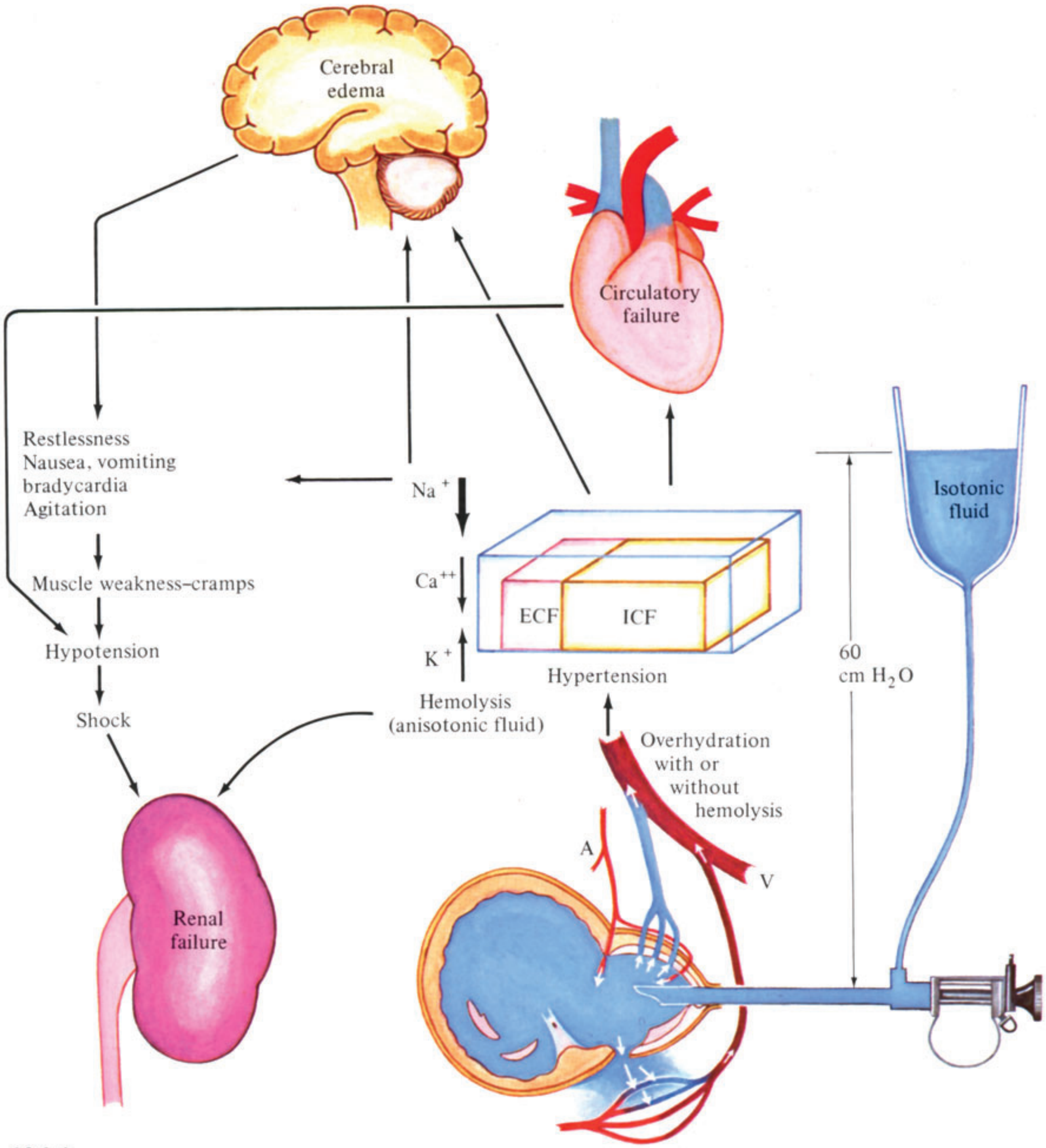
The intravenous administration of appropriate amounts of 5% sodium chloride is recommended to prevent the hyponatremic syndrome if the operation is a long and bloody one.

Intravenous mannitol will definitely serve to prevent the development of this syndrome.[11] Mannitol is an excellent osmotic diuretic and has a potent diuretic effect when injected into the circulation in high concentration. It can mobilize irrigating fluid that is absorbed during transurethral resection. In using mannitol, however, it is necessary to supplement the electrolytes, since its use is accompanied by considerable loss of sodium.

Mannitol as a useful agent for intravenous use in transurethral resection was reported by Bodner in 1964.[3] We have subjected it to considerable modification, and two types of mannitol solutions, for operative and postoperative use, are prepared and employed for routine clinical use.

Solution 1 contains 15% mannitol, 5% glucose, 0.85% sodium chloride, and 0.05% calcium chloride. During a transurethral resection lasting approximately 60 min, 500 ml of this solution are administered intravenously.

Solution 2, for postoperative use, contains 5% mannitol, 5% glucose, 0.25% sodium chloride, and 0.02% calcium chloride. This solution is administered continuously until the next morning at the rate of 200 ml/hour to mobilize substances absorbed during the operation. It corrects abnormal shifts of body fluid electrolytes; it also increases urinary output and obviates the need for frequent catheter irrigation. It diminishes the occurrence of postoperative urinary infection. If the patient has cardiovascular problems, then the rate of infusion is reduced to 100 ml/hour.



106-1

107. Overall Results

Our results are excellent, and in our experience no postoperative acute renal failure has occurred for the past 12 years, even after resecting *exceedingly large prostates (over 150 g) over a 2-hour operative period.*

107-1. Approximately 177 g of tissue fragments were resected from a 79-year-old patient. The resection was done in one stage, and the operation lasted 110 min. The Foley catheter was removed on the fifth day postoperatively. After 2 years, the patient is doing well without complications.

107-1

108. Cryoprostatectomy

Cryothermic destruction of the prostate has proved to be an effective therapeutic measure, especially to poor-risk patients with severe pulmonary or cardiac complications.[21] Generally, these are patients who are thought to be at risk during transurethral resection of the prostate or other standard operative procedures. Patients with advanced prostatic cancers, in whom reduction in tumor mass is helpful to relieve difficulty in micturition, are probably another ideal group of candidates.

Transurethral resection following the cryosurgical procedure to the prostate occurs in a bloodless field. Subsequent removal of sloughed tissue may provide more rapid achievement of a good result.

The advantages of this method are a minimal anesthetic requirement and a bloodless operative field.

The cryosurgical procedure is usually not painful if the instrument is manipulated with care and gentleness. Local anesthesia with xylocaine jelly applied to the instrument 10 min before it is passed into the urethra may be used in poor-risk cases. However, epidural or low spinal anesthesia is recommended, since it relieves the patient's discomfort when the urinary bladder is inflated with air. It also allows palpation of the prostate gland during the procedure and eradicates the pain of trocar cystoscopy, thus allowing an accurate location of the cryoprobe. The operator always needs to be cognizant of the area undergoing freezing.

The patient is placed in a moderate lithotomy position. An extreme lithotomy position with the thighs flexed over the abdomen increases the curve of the urethra, making insertion of the instrument difficult, as there is danger of freezing the bladder wall. The bladder is evacuated and filled with 300–400 ml air.

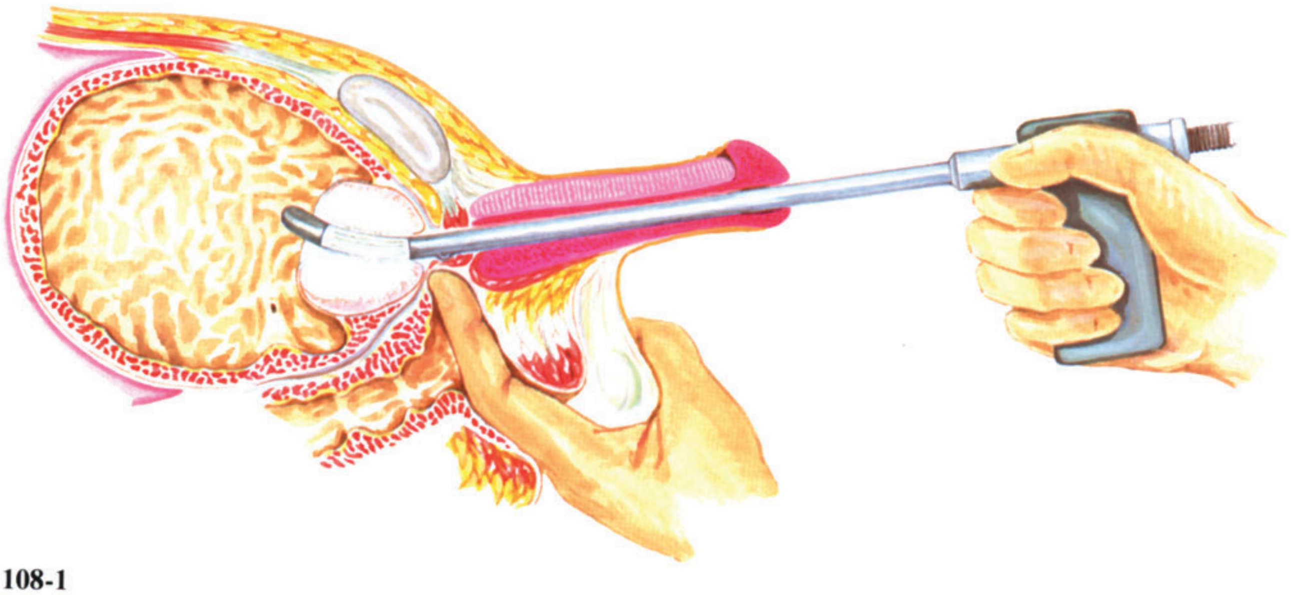
108-1. *The cryoprobe is well lubricated and passed into the prostatic urethra.* Placement of the freezing surface in contact with the prostatic enlargement is facilitated by palpation of the reference knob through the rectum. The knob should be 1 cm from the apex of the prostate. The probe should be kept in a horizontal position, parallel with the patient's body axis, so that the intravesical part of the freezing surface is away from the bladder wall and ureteral orifices.

The temperature control point is set at −175°C, and freezing is started by the introduction of liquid nitrogen into the probe. The freezing segment is fixed to the surrounding tissue in about 10 sec.

Constant palpation is needed to ensure that the rectal mucosa is always movable over the prostatic capsule. When the rectal wall under palpation is felt to be thin, and a cold sensation is felt at the fingertip, freezing is terminated and the heating element is engaged to warm the probe. The probe is freely movable in a few minutes and is withdrawn.

108-2. Besides the standard technique, *suprapubic trocar cystoscopy is extremely helpful in observing the location of the cryoprobe* during partial freezing of the bladder neck area.[17]

The use of a thermistor needle under the rectal mucosa or prostatic apex through the perineum is also helpful to avoid rectal or external sphincter damage by overfreezing.[16,21] A Foley catheter is inserted, the bladder is emptied of air and is irrigated at the end of the procedure. An indwelling urinary catheter is maintained for 3–4 weeks.



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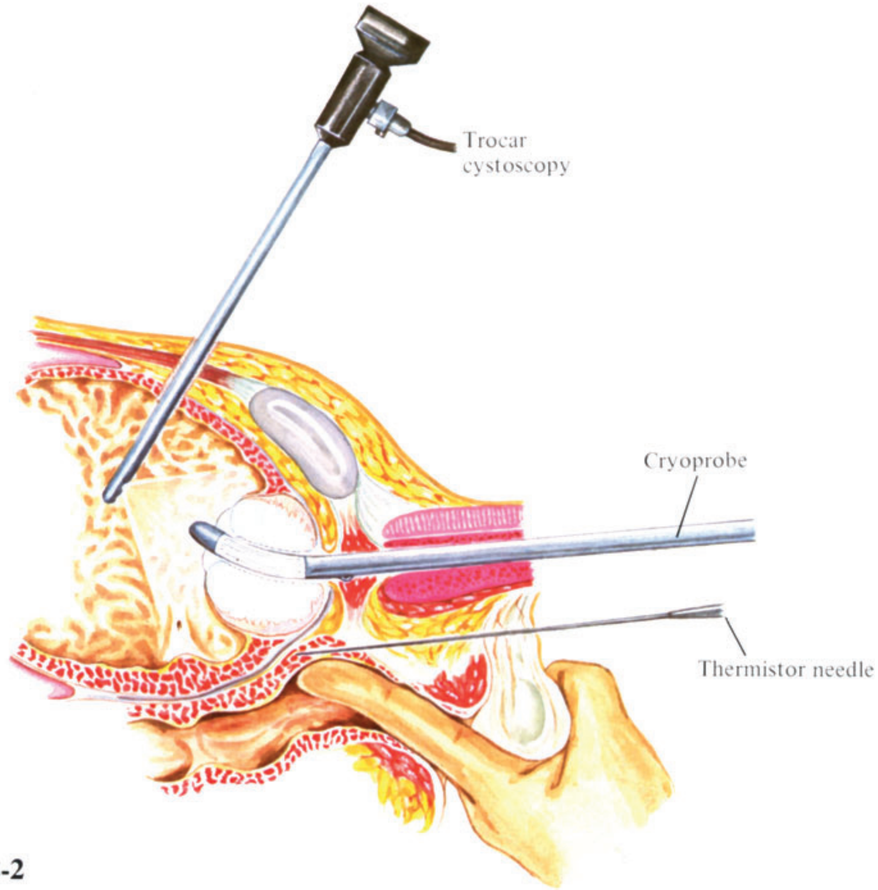

108-2

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Transurethral Resection of Bladder Tumor

9

It is generally agreed that most bladder tumors of low grade and low stage malignancy are best managed by transurethral resection and fulguration. The skilled endoscopic surgeon can safely and adequately remove tumors of any size as long as the neoplasms are accessible with the resectoscope and do not deeply invade bladder wall. Bladder tumors that extend deeply through bladder musculature cannot be removed by transurethral resection. However, the tumors can be managed by transurethral resection for palliation. The tissue obtained may be used in grading and staging the tumor.

Pathology

Most primary bladder tumors are transitional cell (urothelial) tumors, either of the papillary or sessile (broad-based) variety.

Epidermoid or squamous-cell carcinoma may arise directly from the bladder mucosa from leukoplakia, or from papillary transitional cell tumors. In an early stage, epidermoid or squamous-cell carcinoma may be difficult to recognize. It may not project into the bladder cavity but can infiltrate into deep muscle wall. Poorly differentiated squamous-cell cancers frequently show a highly malignant pattern of invasion even in early stages. These tumors are associated with lymphatic permeation far beyond the main tumor even in early stages.

Adenocarcinoma is rare. It was reported in only 17 of 1400 bladder tumor cases at the Bladder Tumor Registry, Armed Forces Institute of Pathology.[1]

Nonepithelial tumors are extremely rare. They are divided into benign connective-tissue tumors and sarcomas; the latter constitute more than half the neoplasms in this category. All sarcomas invade rapidly, extend extravesically, and metastasize.

In the majority of cases, staging and grading of tumors, as described by Jewett and Strong[4] and modified by Marshall,[10] are probably the most important factors in arriving at a reasonable prognostic evaluation.

We believe the years ahead may provide a new diagnostic tool for the staging of infiltrative bladder cancer. Computerized tomography (CT) bladder scans can demonstrate density changes in the bladder wall between tumor and normal wall. The perivesical fat line often seen around the bladder wall is a helpful diagnostic sign. Comparisons between fat density, water, muscle density, and neoplasm can be made by properly focusing on the various tissue densities. Bladder cancer has a higher arbitrary tissue density. Careful infusion of a dilute contrast medium into the bladder lumen enhances the bladder scan. This new modality will help in the proper selection of patients for appropriate therapy—surgery, irradiation, chemotherapy, and/or immunotherapy.

Metastases are rare in the superficial group (O, A, B1), and satisfactory results can be expected by simple removal of the primary tumor. It must be emphasized, however, that 65% of stage B2 tumors have metastasized by the time of initial examination.

According to Jewett et al,[6] the usual O, A, B1, B2, C, D1, D2 staging categories can be converted to the TNM system, as proposed by the International Union Against Cancer; the equivalent stages in both systems are as follows: stage A-T1, stage B1-T2, stage B2 and C-T3, extension outside the bladder with fixation, D-T4. The letter N means lymph node involvement; M means metastases.

Patient Evaluation Before Surgery

Preoperative evaluation of the patient's general condition is similar to that required for transurethral resection of the prostate. Urethral stricture or a large prostate may hinder use of the resectoscope. The surgeon should rule out these possible problems before scheduling the patient for transurethral resection of bladder tumor. A urethral stricture should be dilated to allow passage of a 24F resectoscope sheath without difficulty. An alternative is a perineal urethrostomy. When the patient has a large prostate, it may be necessary to resect it before adequate access to the bladder tumor can be gained. If tumor is located near the hypertrophied vesical neck, it may be necessary to resect the vesical neck before access to the tumor is possible.

Intravenous pyelography should be performed in every patient. Obstruction of one or both ureters usually means that tumor has infiltrated deeply into muscle to the extent that the tumor may not be managed completely by transurethral resection. On occasion we have found that superficial papillary tumors located near or just at the orifice of the ureter may cause urinary obstruction.

Staging of Tumor

At the present time, CT scanning of bladder tumors for staging appears promising.[2] This new modality may revolutionize the diagnostic approach. Preoperative staging of bladder tumors by CT scans may become a routine procedure. The most critical problem the surgeon faces is knowing the depth of infiltration of bladder tumors; one needs to know whether the tumor is penetrating the bladder wall and whether it is fixed to the surrounding tissues.

In bladder tumors, accurate preoperative evaluation of depth of infiltration is not always possible. Large tumors with wide and fixed bases, which are palpable by bimanual pelvic examination, are nearly always deeply invasive. Their extent of invasion can be often demonstrated by pelvic angiography. However, these cases preclude any type of radical surgical treatment. They should be considered as candidates for immunotherapy, chemotherapy, and/or megavoltage irradiation.

It is generally agreed that superficial tumors (stage O, A, B1) are best treated by transurethral resection. The deeply invasive tumors beyond the halfway level in the muscle layer (stage B2) frequently cannot be removed completely by transurethral resection without perforating the bladder wall. In these cases more extensive surgical measures, such as partial, total, or radical cystectomy should be considered.

Staging should be precise when it is based on the microscopic study of the removed tumor and muscle at the site of deepest infiltration. However, clinical staging before removal of the whole layer of bladder wall is also helpful, although it will be less precise then pathologic staging.

A remarkably high degree of accuracy can also be achieved by careful bimanual pelvic examination under anesthesia and is combined with transurethral bladder biopsies and resection of the involved bladder wall.[5] Palpable tumor within the bladder wall, with rare exception, represents deep infiltration of tumor. Therefore, the major problem concerns the staging of tumors that cannot be felt by bimanual pelvic examination (Fig. 1).

Clinical staging of nonpalpable tumors depends principally on tissue removed by transurethral resection. In our experience, the majority of early nonpalpable tumors can be completely removed by transurethral excisional biopsy.[9]

The steps consist of the following: 1) resecting all the tumor mass that projects into the bladder lumen down to the level of surrounding mucosa and placing the tumor in specimen bottle one; 2) resecting the bladder muscle beneath and at the periphery of the tumor, usually to the depth of one loop, and placing the tumor fragments in specimen bottle two; 3) resecting a thin layer of deeper wall, if it is possible, when tumor tissue is demonstrated on frozen section in tissue fragments at the convex border of the tumor (see Figs. 108-1 and 108-2).

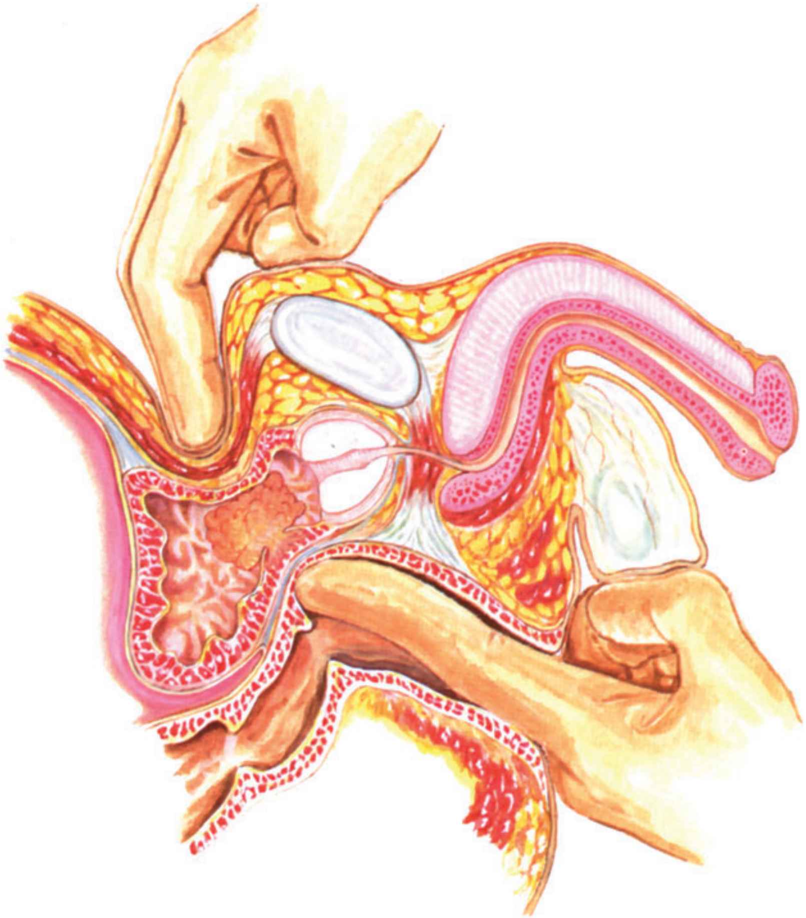


FIG. 1. Bimanual pelvic examination in tumor staging.

Microscopic invasion into deep muscle should be suspected when tumor cells are detected on the convex side of the semicircular resected muscle slivers. These tumors should be diagnosed as stage B2 or higher. Tumors that have invaded only the concave side or flat side and have not reached the convex side are nearly all in stage B1. The tumors that have invaded the submucosa but have not reached the muscle layer are usually in stage A, and tumors that are limited to mucosa are usually in stage O. According to Jewett,[5] staging by multiple biopsies carefully performed by transurethral resection is very reliable, and on the basis of bimanual pelvic examination of the bladder, unsuspected deep infiltration is rather rare in this nonpalpable group.

A skilled endoscopic surgeon can completely remove nearly all superficial tumors (stage O, A, B1) in this fashion. More than two-thirds of all patients with bladder tumor can be satisfactorily treated by transurethral excisional biopsy while the results of pathologic staging and grading are awaited.

Our current criteria for choice of treatment for bladder tumor are schematized in Fig. 2.

All bladder tumor sites accessible by the resectoscope are suitable for transurethral resection. They include the moderate-sized tumors with either distinct or indistinct margins, which are not palpable by bimanual pelvic examination. In our experience, nearly 67% of all bladder tumor cases seen initially are in this group. Nearly 89% of patients with previous transurethral resections survive 5 years.

The large tumors, single or multiple, and palpable by bimanual pelvic examination are no longer suitable for transurethral resection as a therapeutic measure but undergo the procedure for grading and staging.

Inaccessible tumors in low stages are usually well managed by open electroresection through the suprapubic approach (see Figs. 46-1 and 46-2).

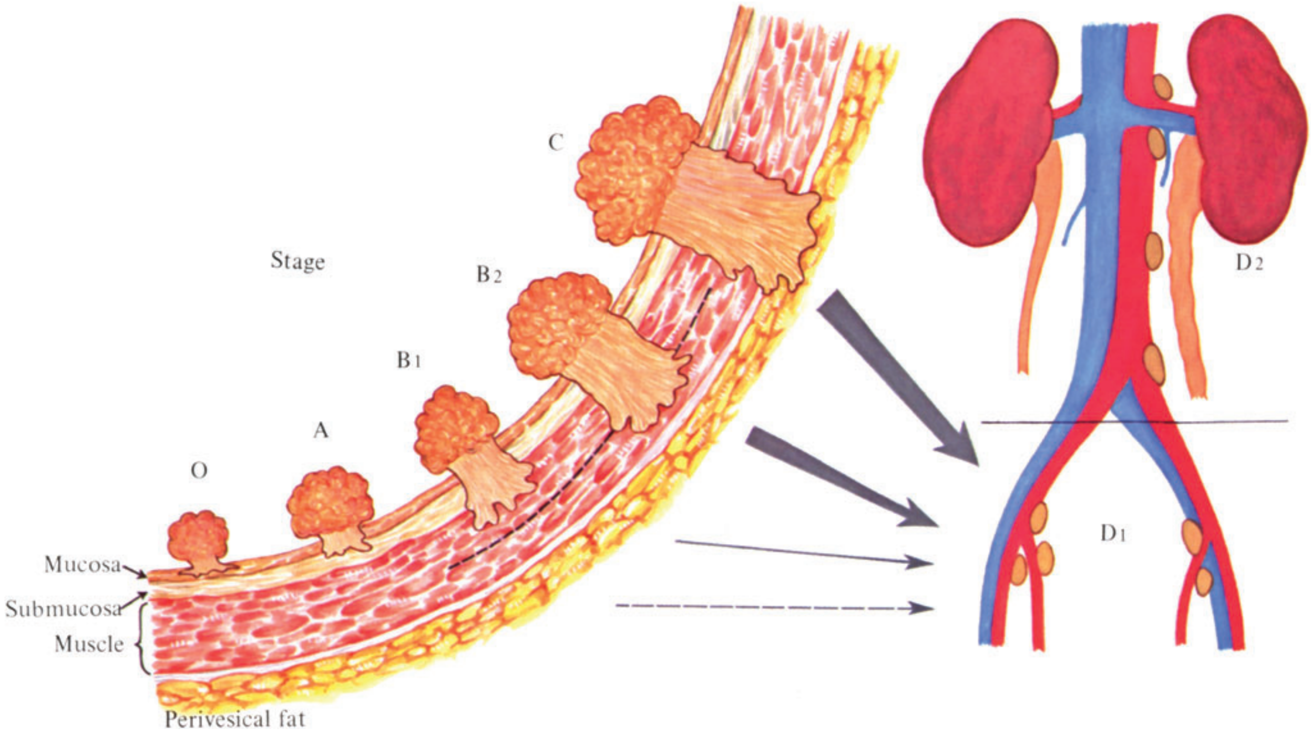


FIG. 2. Schematic of stages of bladder tumor.

Regardless of location, nearly every tumor can be removed by transurethral resection; success depends largely upon the training and skill of the surgeon. A tumor located in a vesical diverticulum is one of the most difficult to remove endoscopically. In our experience, nearly 99% of primary bladder tumors are accessible with the resectoscope.

For those inaccessible tumors that deeply invade muscle, partial cystectomy, total cystectomy, or radical cystectomy should be considered, depending on their grade and depth of infiltration.

Those tumors that have spread to perivesical tissue and beyond as metastases are usually not susceptible to complete surgical removal. They are best treated by immunotherapy, chemotherapy, and/or radiotherapy. Palliative operative procedures, such as urinary diversion and ligation of the internal iliac artery for bleeding are performed if indicated.

Preparation of the Patient and Anesthesia

The preoperative preparation is similar to that used in transurethral prostatic resection. A mild sedative is administered the night before. An enema is given the night before or the morning of the operation. Preoperative infection is treated by appropriate antibiotic therapy before the transurethral procedure.

Low spinal anesthesia is usually sufficient for the majority of cases. Epidural anesthesia is not adequate. The obturator muscular reflex that is caused by stimulation of the obturator nerve cannot be avoided with epidural anesthesia. Straining and sudden movement of the patient's leg during electroresection is seen when the high frequency current is being used. Complete perforation of the bladder wall may occur in this instance. General anesthesia with an endotracheal tube and adequate use of muscle relaxants is recommended when deep resection is attempted at the lateral wall near the ureteral orifice, a site near the obturator nerve.

Postoperative Management and Follow-up

A 22 French Foley catheter is used for postoperative urinary drainage and is maintained as long as hematuria is evident. If the tumor is small, the catheter is left indwelling for only a few days.

The use of appropriate antibiotics is recommended for treatment of existing infections and to prevent septicemia. Maintenance of a high fluid intake with the intravenous use of mannitol solutions will increase urinary output, obviate the need for catheter irrigation and will diminish the occurrence of postoperative urinary infection.

Cystoscopic examination of the patient for possible recurrence is carried out at 3-month intervals for high-grade tumors and at 4-month intervals for low-grade tumors during the first 2 years. Cystoscopy procedures are increased to 6-month intervals during the second and third years; then they are performed at yearly intervals.

In most instances, the resected bladder wall will show complete healing in 3 or 4 months after transurethral resection. Extensive fulguration or previous high-dose megavoltage irradiation may retard healing however.

Recurrence of tumor of equal or higher grade malignancy at the original site on the bladder wall is a grave clinical sign.[9] In most instances this means either that the previous transurethral resection was inadequate, or that infiltration was of a higher stage that cannot be completely removed even by a skilled surgeon. If there is a raised edge at the periphery of the resected area, it signifies unresected tumor; the patient should be readmitted for transurethral resection.

If there is a recurrent wide-based tumor at the bottom of the previously resected scar, it usually signifies that the tumor has invaded far more deeply and cannot be removed by transurethral resection. The patient should be readmitted for partial or total cystectomy and lymph node dissection. Preoperative megavoltage irradiation should also be administered (2000 rad) prior to surgery.

Complete healing of the resected bladder wall, covered by urothelium, signifies complete transurethral resection of bladder tumor in that area, even though there might be multiple recurrences in other areas of bladder mucosa. Transurethral resection should be repeated to remove these new tumors regardless of the number of recurrences as long as they are accessible with the resectoscope.

Operative Techniques

109. Routine Strategy

The position of the patient on the operating table and the preparation of the operative field are the same as those employed in transurethral resection of the prostate. After satisfactory anesthesia is induced, bimanual pelvic examination is performed. A plastic anal-rectal shield for the finger is useful for this purpose.

The number and size of each lesion and the degree of infiltration must first be estimated. The resection is then begun on the surface of the lesion. The loop is always placed at the posterior and superior borders of the lesion to begin the resection. Bleeders must be controlled individually as they occur, to maintain good visualization throughout the procedure. The steps of resection are as follows:

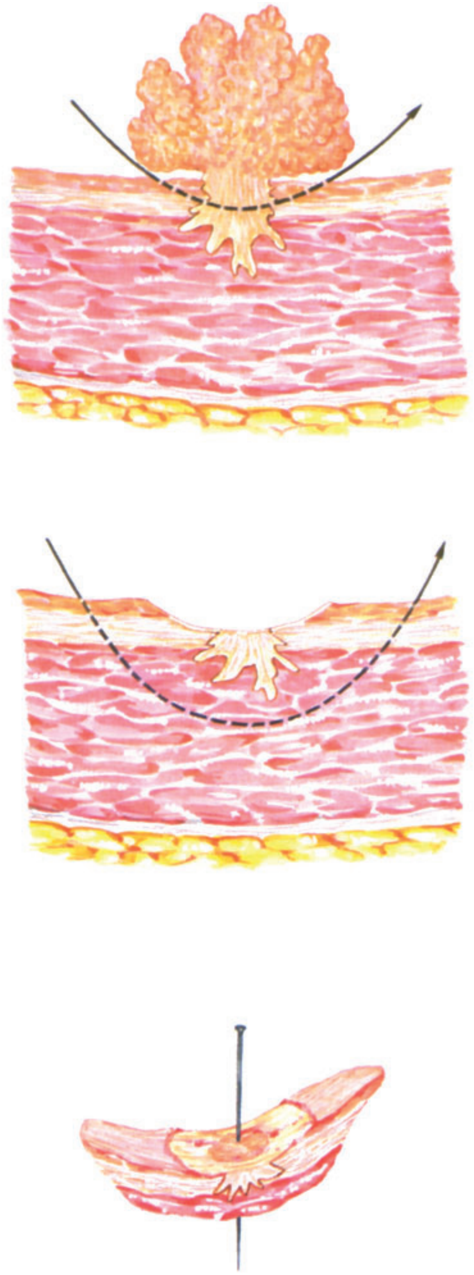
109-1. *The tumor mass that projects into the bladder cavity is resected down to the level of the bladder mucosa.* Fragments are placed in specimen bottle one.

109-2. *Bladder muscle beneath and at the periphery of the tumor is usually resected to the depth of one loop.* Sections of this tissue are placed in specimen bottle two.

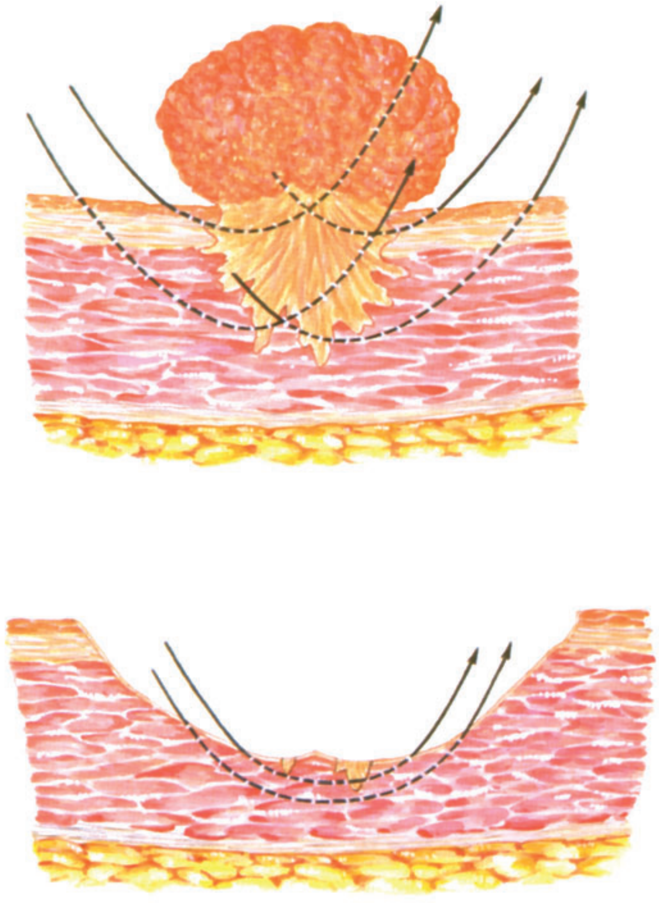
109-3. *A thin layer of tissue from deeper muscle is resected,* if it is possible, when tumor has been proved by frozen section in tissue fragments obtained at the convex border of the tumor. This thin section is also placed in bottle two.

It is usually inadvisable to go deeper than one loop in diameter, but an experienced surgeon can go deeper into the muscle layer, even at the upper portion of the bladder.

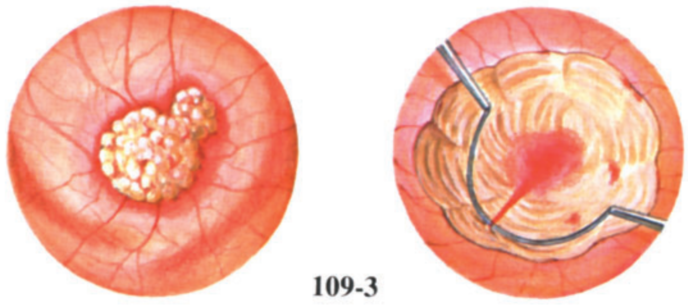
The pathologist should be oriented regarding the significance of different tumor containers; he must be informed of the fact that the deep side of each tissue fragment will have a convex contour corresponding to the shape of the loop. The insertion of a pin through selected tissue fragments, from superficial to deep, for frozen section is of great assistance to the pathologist; this helps to orient him in preparing the vertical tissue sections and in properly staging the tumor. Gross invasion deep in the muscle layer can be recognized by the granular appearance of the resected surface, with a lack of normal pattern in the muscle fibers.



109-1



109-2



109-3

110. Specific Operative Hints

The Bladder Should Not Be Distended with Fluid. When the bladder is over distended with irrigating fluid, the wall becomes thin and may be easily perforated even with a shallow scoop of the resectoscope. In addition, the lesion fades away from the tip of the resectoscope as the bladder becomes distended, and the procedure becomes more difficult and troublesome.

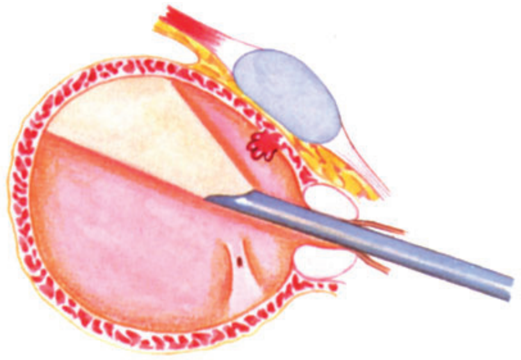
110-1. *A lesion near the anterior or lateral vesical neck may fall away from the visual field* of the resectoscope as the bladder becomes distended, and this also makes the tumor inaccessible.

110-2. On the other hand, *when the bladder is not distended, the lesion is more easily visualized and may be caught by the loop.* The bladder wall is also thicker in its nonfilled state and will not be easily penetrated even by a deep resection.

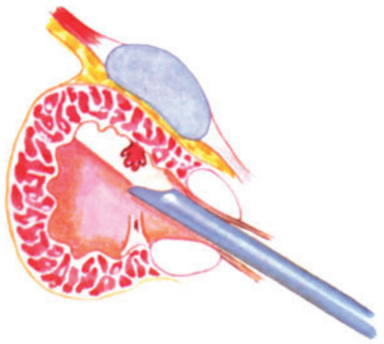
Once a deep resection is made in the bladder wall, overdistention of the bladder is avoided to prevent secondary rupture of the bladder wall. Therefore, the surgeon frequently empties the bladder and never overdistends the bladder with irrigating fluid throughout the operative procedure.

Use the Other Hand as an Aid During Resection

110-3. *Elevation of the bladder wall* with the index finger of the opposite free hand in the rectum or vagina *is very helpful in gaining access to the lesion* with the resectoscope loop.



110-1



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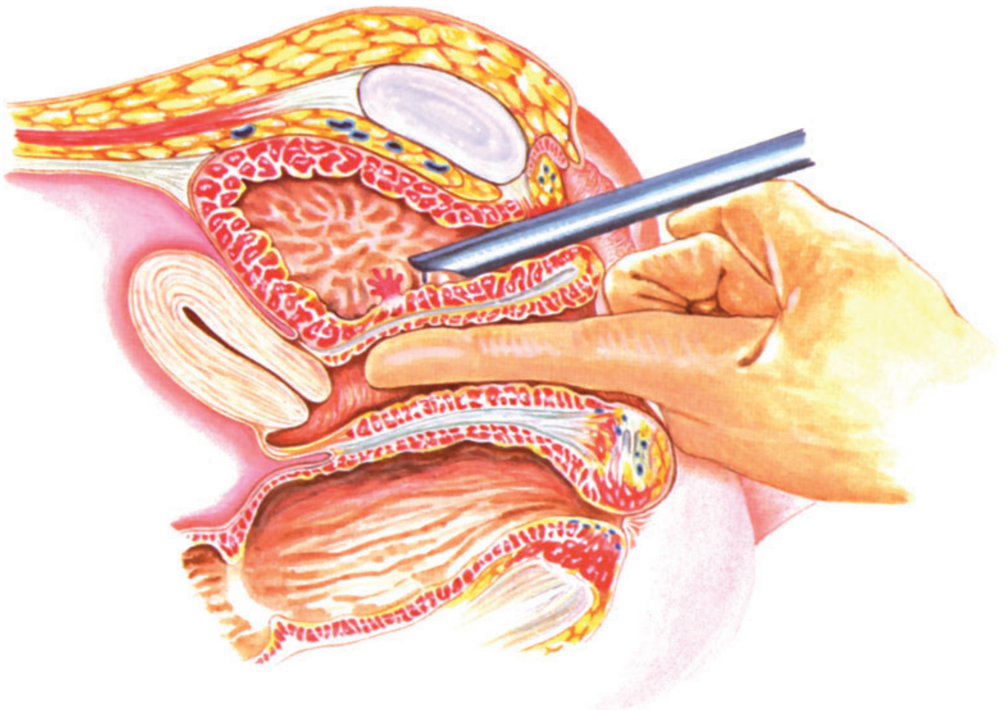
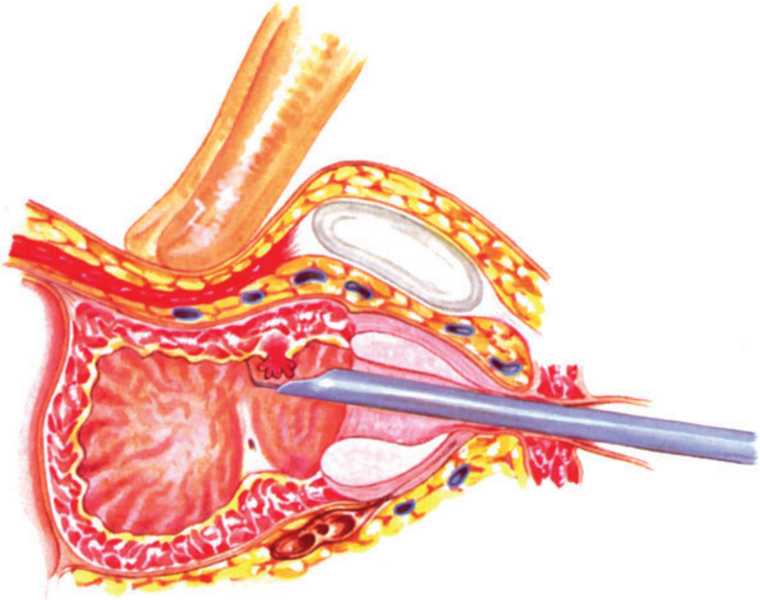


110-3

110-4. *Compression of the suprapubic abdomen is also a helpful technique* in gaining access to a lesion at the dome or anterior wall of the bladder. Use of the one-hand resectoscope is recommended for these procedures.



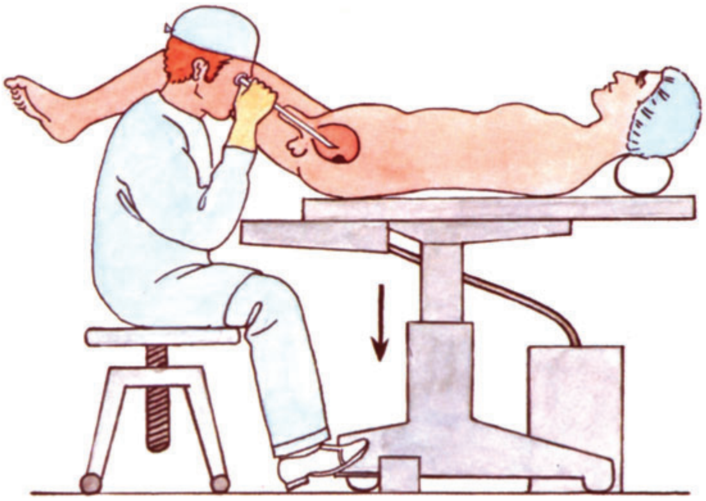
110-4

111. Patient Positioning

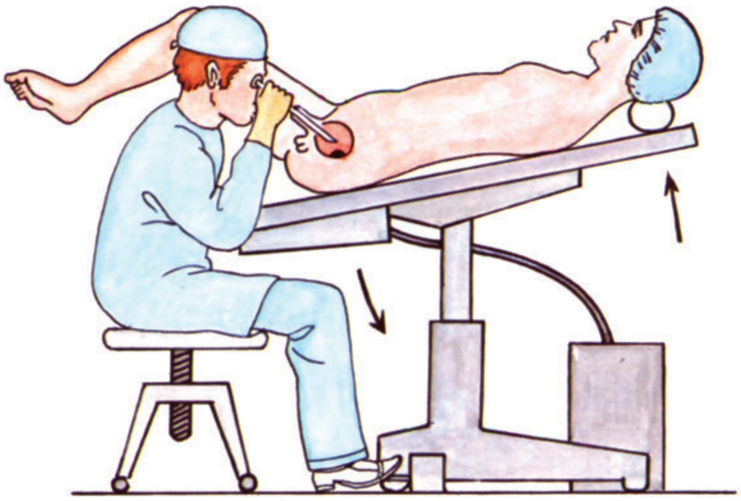
The position of the patient is the same as that used for routine cystoscopy. The knees should be widely spread to allow adequate space between them for manipulation of the resectoscope, especially in resecting a lesion at the lateral wall of the bladder.

When a lesion is observed at the anterior wall of the bladder, the thighs should be at a less acute angle with the body. Sharply abducted thighs displace the posterior urethra downward into the perineum, limiting accessibility of the resectoscope to the lesion at the anterior wall and dome of the bladder.

111-1. *The operating table is lowered and the surgeon's chair elevated for resecting a lesion in the recess behind the trigone or posterior wall.* This position places the instrument in a more direct line to the lesion.



111-1



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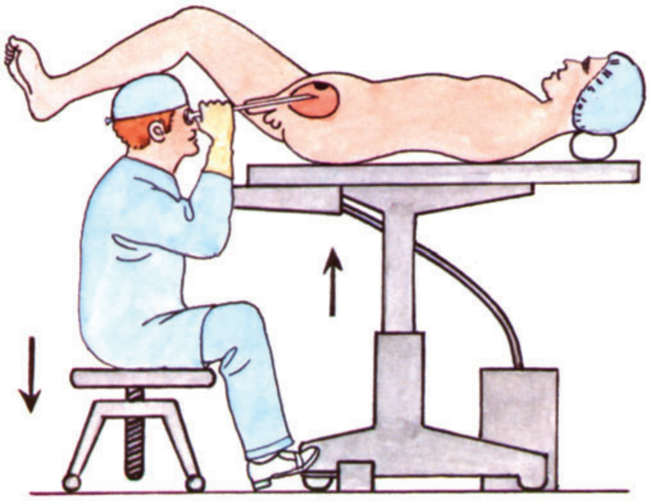
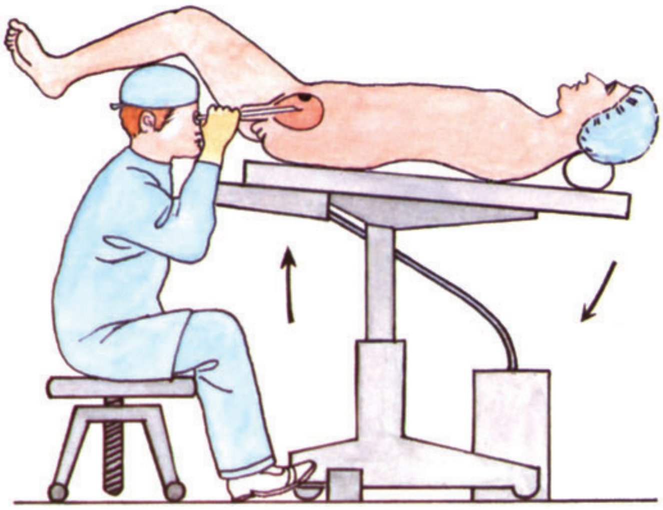


111-3



111-4

111-2. This advantage becomes more evident when *the operating table is shifted to the head-up and hip-down position.*

111-3. *Raising the operating table and lowering the surgeon's chair when a lesion is located on the anterior bladder wall helps the surgeon gain access to the lesion.*

111-4. This advantage also becomes more evident if *the operating table is shifted to the head-down and hip-up position.*

An effective combination of these three techniques increases the surgeon's access to the bladder lesions. In our experience, about 99% of early stage tumors are accessible with the resectoscope.

Management of Complications

Operative and Postoperative Bleeding

Bleeding should be controlled as it occurs during the procedure. All arterial bleeders should be completely controlled before the transurethral resection is terminated. Sudden elevation in blood pressure or any straining, retching, or abrupt movement of the patient, after the patient has been moved from the operating table, may result in profuse bleeding. Vigorous bleeding, not controlled by continuous irrigation, is usually from one of the bladder arterioles at the resected area. It is recommended that the patient be returned to the operating room so that the bleeding points may be fulgurated. It is unwise to procrastinate, hoping for spontaneous cessation of bleeding. Blood loss can be quite significant and must be replaced.

The quantity of blood lost cannot be accurately measured; gross estimations can be made by hemoglobin determinations during and after the operative procedure. It is advisable to start blood replacement before signs of shock appear.

Secondary hemorrhage is not frequent but may be anticipated 1 or 2 weeks after transurethral resection. It usually results from separation of the eschar from the resected bladder wall; delayed bleeding occurs if there is retained, devitalized tissue and infection. Bleeding usually is managed by bladder irrigation with removal of all clots and indwelling catheter drainage for 1 or 2 days.

Perforation of the Bladder

Perforation of the bladder into the perivesical space is of no serious consequence if extravasation is recognized early and is limited to a small area. If any tumor is left at the time this occurs, care should be taken not to overdistend the bladder. The resection should be completed and hemostasis obtained while the bladder is only partially filled with irrigating fluid.

Foley catheter drainage should be maintained for at least 4–5 days. Irrigation of the bladder with an antitumor solution at the termination of the operation may be an effective measure in preventing tumor dissemination to the perivesical tissue. For example, thio-tepa in the United States,[7,14] triethylene glycol diglyceridyl ether (Epodyl) in Great Britain, and mitomycin in Japan[3,8,12,13] have been used for this purpose.

If extensive extravasation through a perforation of the bladder wall is suspected and if pain and swelling are predominantly suprapubic, surgical drainage should be instituted immediately. The technique is similar to that used for perforation of the prostatic capsule (see Fig. 105-5). A small incision is made in the midline just above the symphysis pubis and extends through the fascia. The rectus abdominis muscles of the abdomen are separated, the prevesical space down to the region of the prostate is opened by blunt finger dissection, and one or two Penrose drains are inserted depending on the size of perforation.

Intraperitoneal Perforation

This complication should be infrequent. The patient under spinal anesthesia will almost immediately complain of pain under the left diaphragm.[11] Treatment is an immediate laparotomy to drain the intraperitoneal fluid and close the perforated wound in the bladder. If any tumor remains, a partial cystectomy may be performed at this time.

Damage to the Ureteral Orifice and Subsequent Obstruction

Damage to the ureteral orifice can occur during resection of a tumor near or at the orifice. The main problem to be avoided during resection of the tumor is destruction of a ureteral orifice. This complication may lead to ureteral stricture and partial or complete obstruction. It is important, therefore, to recognize the orifices. Indigo carmine given intravenously (5 ml) can help in locating the orifice. When ureteral damage occurs, the patient must be observed after the operation; every attempt must be made to preserve kidney function.

The ureter does not usually become obstructed if the pure cutting current and a fine gauze loop are used. The use of a blended or coagulating current is harmful to the ureteral orifice. When an active bleeder is observed near the ureteral orifice, careful "spot coagulation"[11] should be done just on the bleeding point. Multiple coagulations of a large area should be avoided.

When damage to a ureteral orifice is observed, no special measures are required at the time of operation. The danger lies in fibrosis and stricture formation. Stricture of both ureters may lead to loss of kidney function. The patient should be under careful observation. Creatinine determinations should be obtained at intervals. Necessary measures to relieve obstruction, such as ureteroneocystostomy, should be executed before the kidney loses significant function.

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